

# **LIVERWORTS OF THE WESTERN HIMALAYAS AND THE PANJAB PLAIN**

(ILLUSTRATED)

## **PART II**

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## PREFACE.

The first part of this book appeared in 1929 and dealt with the Anthocerotales, the Marchantiales, the Anacrogynous Jungermanniales, and the Sphærocarpales. The present volume was intended to deal with the Acrogynous Jungermanniales only, but in order to bring together the Jungermanniales, the Anacrogynæ and the closely allied order Sphærocarpales have also been included. These latter have also been brought up to date.

In addition to the specimens in the Panjab University herbarium a collection of Liverworts at the herbarium of the Forest Research Institute, Dehra Dun, has also been examined by Mr. R. S. Chopra through the courtesy of Mr. C. E. Parkinson, Forest Botanist.

The species described by Stephani from the Western Himalayas in his 'Species Hepaticarum' but not seen by the author and a few similar species given by Gola have been included as was done in the previous volume. The chief reason for this procedure is to enable future investigators to identify these species if met with within the area or as is likely to reduce at least some of the species as synonyms. As was pointed out in the Introduction to Part I of this work the very great variability of many of the Liverworts must always be taken into consideration in deciding the limits of various species.

The author's thanks are due to Mr. F. Verdoorn for the determination of the *Frullanias* in the Panjab University herbarium, to Prof. Herzog for the determination of a few species of *Lejeunea* and to Mr. W. E. Nicholson for determining a number of species of other genera. He is greatly indebted to Mr. R. S. Chopra for his untiring and energetic help in the preparation of this book. All the diagrams have been drawn by him. The book would not have been out for a long time but for his enthusiasm and energy.

# CONTENTS.

	PAGE
PREFACE .. .. .	i
TABLE OF CONTENTS .. .. .	v
CONSPECTUS .. .. .	1
KEY TO THE GENERA. .. .. .	7
LEJEUNEACEÆ .. .. .	10
MADOTHECACEÆ .. .. .	26
PLEUROZIACEÆ .. .. .	43
RADULACEÆ .. .. .	43
SCAPANACEÆ .. .. .	47
PTILIDIACEÆ .. .. .	50
CEPHALOZIACEÆ .. .. .	54
LOPHOZIACEÆ .. .. .	60
CALOBRYACEÆ .. .. .	91
CODONIACEÆ .. .. .	91
BLYTTIACEÆ .. .. .	106
ANEURACEÆ .. .. .	106
RIELLACEÆ .. .. .	114
SPHÆROCARPACEÆ .. .. .	115
SYNOPSIS .. .. .	117
APPENDIX I .. .. .	123
APPENDIX II .. .. .	126
APPENDIX III .. .. .	129
INDEX .. .. .	135

## CONSPECTUS.

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# JUNGERMANNIALES.

Gametophyte a thallus or differentiated into stem and leaves, with little histological differentiation. Scales usually absent. Rhizoids always smooth. Archegonia usually arranged in groups but never on stalked receptacles, antheridia superficial, occasionally immersed in cavities, globular, on slender stalks. Sporogonium with foot and seta. Capsule wall two or more cells thick. Elaters present. Dehiscence usually by four valves.

## SUBORDER *Acrogynæ*.

Gametophyte with stem and two rows of lateral and frequently a third row of ventral leaves (amphigastria). Archegonia usually in a cluster, terminal.

The relative position of the families in the *Acrogynæ* is by no means clear and much more work shall have to be done before it is possible to put them in their proper places. It should not be understood, therefore, that the families in this book have been placed in the order of evolution. They have been arranged more on the basis of practical convenience and according to the order followed by Cavers (*The Inter-relationships of the Bryophyta*, New Phyt. Rep., No. 4, 1911).

## FAMILY I. LEJEUNEACEÆ.

Leaves alternate, incubous, complicate-bilobed, postical lobe (lobule) small, commonly inflated or saccate. Amphigastria usually present. Rhizoids arising from the base or the middle of the amphigastria. Male shoots (androcæcia) lateral; antheridia one or two in the axil of each bract. Archegonia terminal, one or more in a cluster. Perianth free from the involucre bracts, 3-12-plicate, rarely terete, the apex constricted into a short tubular beak.

Capsule on a short pedicel, globose, 4-valved for  $\frac{1}{2}$  of its length, the lower third solid. Elaters few, monospiral, attached to the inside of the capsule wall by their upper pointed ends, the lower free trumpet-shaped ends reaching the floor of the capsule.

## FAMILY II. MADOTHECACEÆ.

Plants large. Stems usually regularly bi- or tri-pinnate. Rhizoids scarce, arising from the base of the amphigastria. Leaves incubous, complicate-bipartite almost to the base, antical lobe large, postical (lobule) flat, much smaller, nearly parallel to the stem. Amphigastria resembling the lobules but broader, frequently decurrent at the base. Androecia short, lateral, bracts nearly equally bilobed, opposite; antheridia solitary. Archegonial cluster terminal on very short lateral branches; bracts usually a single pair. Perianth suboval, more or less compressed dorsiventrally in the anterior portion, mouth becoming bilabiate or campanulate by the extrusion of the capsule. Calyptra of several layers of cells. Capsule shortly pedicellate, globose, 4-valved, the valves often irregularly split and rarely separating down to the base. Elaters short, 2-3-spiral. Only genus *Madotheca*.

## FAMILY III. PLEUROZIACEÆ.

Plants usually large, with erect stems from a rhizomatous base, branches lateral. Leaves incubous, nearly always two-lobed, antical lobe large, postical lobe smaller, saccate, its narrow mouth often closed by a complicated valve apparatus. Amphigastria absent. Antheridia and archegonia on short lateral branches. Androecia small, bracts in 6-12 pairs, imbricate, monandrous. Perianth elongate and narrow, generally 4-10-plicate, the mouth contracted. Capsule oval, 4-valved to the base. Elaters deciduous, bispiral. Only genus *Pleurozia*. (Not represented in the Western Himalayas.)

## FAMILY IV. RADULACEÆ.

Plants generally of medium size, closely attached to the substratum. Stems laxly pinnate or subpinnate. Leaves incubous,

complicate-bilobed, the postical lobe (lobule) smaller with its free margin generally appressed to the under side of the antical lobe; rhizoids arising from the under surface of the lobule. Amphigastria absent. Androecia terminal, bracts with 1 or 2, rarely 3, antheridia. Archegonial cluster terminal on the main stem generally, frequently with 1-2 sub-involucral innovations. Perianth usually strongly dorsi-ventrally compressed, rarely subterete, very rarely plicate, the mouth wide, truncate, bilabiate. Capsule shortly and stoutly pedicelled, generally oval-cylindrical, 4-valved to the base, the wall of two layers of cells. Only genus *Radula*.

#### FAMILY V. SCAPANIACEÆ.

Plants usually large. Branches usually lateral. Leaves alternate, complicate-bilobed, the antical lobe smaller than the postical lobe (lobule). Amphigastria usually absent. Androecia terminal, spicate; bracts di-poly-androus. Perianth free, dorsi-ventrally compressed, or subinflated and 4-pluri-plicate. Capsule 4-valved to the base.

#### FAMILY VI. PTILIDIACEÆ.

Plants of medium size, branched, branches lateral or postical. Leaves incubous or transverse, seldom succubous, bi-multi-fid, frequently ciliate or ending in hair-like points. Amphigastria always present and nearly resembling the leaves in shape and size. Androecia terminal, spicate, bracts 1-3-androus. Archegonia terminal on main stem or lateral branches but never on postical branches, bracts many. Perianth absent, or when present 3-10-plicate, contracted or truncate at the mouth, free or adnate to the innermost bracts. Capsule usually shortly pedicellate, ovate with straight valves, or cylindrical with twisted valves.

#### FAMILY VII. CEPHALOZIACEÆ (TRIGONANTHEÆ Spr.).

Plants large or small. Stem prostrate or procumbent, branching generally pinnate, postical flagellæ often present. Leaves

alternate, rarely opposite, usually incubous, usually lobed or toothed, rarely entire. Amphigastria usually present. Male bracts mon-androus, rarely di-androus. Bracts of the female inflorescence tristichous, in a few distichous. Perianth usually free, somewhat elongated and narrow, trigonous, the third angle postical, rarely (by intercalation of secondary angles) 4-6-gonous. Calyptra free, narrow. Capsule oblong or cylindrical, wall of two layers of cells, in a few genera of four or five layer of cells, valves straight.

### FAMILY VIII. LOPHOZIACEÆ (EPIGONANTHÆÆ Spr.).

Plants usually medium or small. Stem irregularly branched, very rarely pinnate, branches almost always lateral. Leaves succubous or transversely inserted, entire or 2-lobed, seldom 3-5-lobed. Amphigastria generally absent or very small, very rarely large. Inflorescence generally terminal on the main shoots. Male bracts 1-10-androus. Perianth (when present) compressed from the sides, cylindrical, ovate or trigonous with the third angle always antical. Capsule mostly ovate or cylindrical, 4-valved to the base.

#### SUBORDER *Anacrogynæ*.

Gametophyte generally a thallus, sometimes with stem and leaves. Sex organs on the antical (dorsal) side. Archegonia generally in groups.

### FAMILY IX. CALOBRYACEÆ.

Stems erect, arising from a fleshy rhizome-like basal portion. Leaves arranged radially and more or less regularly in three rows, simple. Rhizoids absent. Female inflorescence on the upper part of the stem, without any involucre. Calyptra large, cylindrical. Capsule cylindrical, the wall of one layer of cells except at the apex, with longitudinal annular thickenings. Elaters bispiral.

Not represented by any species in this area.



FAMILY X. CODONIACEÆ.

Thallose or more or less foliose. In the foliose forms the leaves in two rows, parallel to the stem or obliquely inserted and succubous. Archegonial group surrounded by a perianth (involucre). Capsule usually with a long seta, globose or oval, dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells, well-developed fibrous bands being usually present on either the outer or the inner cells, or on both. Elaters adherent to the base of the capsule or partly free, more rarely altogether free, 2-4-spiral.

FAMILY XI. BLYTTIACEÆ.

Thallus with a distinct and usually sharply defined midrib, male and female inflorescence on the dorsal surface of the thallus, not on special branches, the archegonia in groups. Involucre double or single. Capsule generally cylindrical, usually dehiscing incompletely by 2-4 valves, the inner wall without semi-annular thickenings.

Not represented by any species in this area.

FAMILY XII. ANEURACEÆ.

Thallus fleshy or membranous, in *Metzgeria* with a sharply defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, wall usually composed of two layers of cells of which the inner possesses more or less distinct semi-annular bands. Elaters either free and tapering towards each end, with one broad spiral band; or also fixed, short and obtuse with an indistinct spiral band, and persistent as erect tufts at the apex of the valves.

SPHAEROCARPALES.

Gametophyte a thallus, without air-chambers and pores. Rhizoids smooth. Each antheridium and archegonium enclosed

in a special envelope. Sporogonium with a large foot and a short seta. Capsule wall one-layered without fibrous bands on the cells. No definite elaters, only sterile cells which are thin-walled and disappear at maturity. Dehiscence irregular.

#### FAMILY XIII. RIELLACEÆ.

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters same as those of the order.

#### FAMILY XIV. SPHAEROCARPACEÆ.

Thallus without a distinct midrib, of one layer of cells towards the margin, entire or lobed, involucre of sex organs closely grouped, pear-shaped or conical. Spores usually permanently united in tetrads.

Not represented by any species in this area.

# KEY TO THE GENERA DESCRIBED IN THIS BOOK.

- 1 { Plants aquatic with a median-dorsal wing .. *Riella*
- 1 { Plants terrestrial or aquatic, no median-dorsal wing .. 2
- 2 { Plants with a midrib and lateral wings, not divided into leaf-like lobes .. 3
- 2 { Plants with leaf-like lateral lobes .. 8
- 3 { Plants with tuber at the apex .. 4
- 3 { Plants without apical tubers .. 5
- 4 { Plants with dorsal lamellæ .. *Petalophyllum*
- 4 { Plants without dorsal lamellæ .. *Sewardiella*
- 5 { Sex organs on small shoots .. 6
- 5 { Sex organs on the ordinary main shoots .. 7
- 6 { Fertile shoots small, ventral; midrib distinct, narrow; wing 1-cell thick .. *Metzgeria*
- 6 { Fertile shoots lateral, wing thick, gradually thinning outwards .. *Aneura*
- 7 { Sex organs without scales, antheridia in pits .. *Pellia*
- 7 { Sex organs with scales, antheridia not in pits .. *Calycularia*
- 8 { Plants with *Nostoc* colonies and flask-like gemmæ receptacles .. *Blasia*
- 8 { Plants without the above characters .. 9
- 9 { Archegonia dorsal, rhizoids purple, leaves crisped, apical tubers .. *Fossombronia*
- 9 { Archegonia terminal .. 10
- 10 { Leaves divided almost to the base into 3-5 segments .. *Blepharostoma*
- 10 { Leaves entire or not so deeply divided .. 11
- 11 { Leaves and amphigastria alike, deeply bilobed, or 3-5-lobed .. 12
- 11 { Amphigastria unlike the leaves, or absent .. 13
- 12 { Leaves deeply bilobed .. *Anthelia*
- 12 { Leaves 3-5-lobed .. *Lepidozia*

13	{	Amphigastria present (absent in one species of <i>Lejeunea</i> ) .. .. .	14
		Amphigastria absent .. .. .	20
14	{	Amphigastria small, deeply bilobed .. .. .	15
		Amphigastria large, entire or toothed .. .. .	16
15	{	Leaves strongly spreading, gemmæ absent, archegonia on short lateral shoots .. .. .	<i>Chiloscyphus</i>
		Leaves usually erect, gemmæ very frequent, archegonia on main shoots .. .. .	<i>Lophocola</i>
16	{	Leaves not complicate-bilobed .. .. .	17
		Leaves complicate-bilobed .. .. .	18
17	{	Leaf apex toothed, flagellæ frequent .. .. .	<i>Mastigobryum</i>
		Leaf apex entire flagellæ absent .. .. .	<i>Calypogeia</i>
18	{	Lobule flat, more or less parallel to the stem .. .. .	<i>Madotheca</i>
		Lobule saccate to galeate, at right angles to the stem .. .. .	19
19	{	Lobule galeate (rarely evolute) .. .. .	<i>Frullania</i>
		Lobule saccate (rarely obsolete) .. .. .	<i>Lejeunea</i>
20	{	Leaves complicate-bilobed .. .. .	21
		Leaves not complicate-bilobed .. .. .	23
21	{	Lobule smaller than the lobe, with rhizoids arising from its under surface .. .. .	<i>Radula</i>
		Lobule larger than the lobe .. .. .	22
22	{	Perianth contracted at the mouth .. .. .	<i>Diplophyllum</i>
		Perianth not contracted, mouth wide .. .. .	<i>Scapania</i>
23	{	Plants thin, pellucid .. .. .	<i>Cephalozia</i>
		Plants not thin and pellucid, but robust .. .. .	24
24	{	Leaves oblique, 2-3-lobed or toothed .. .. .	25
		Leaves transverse, entire .. .. .	26
25	{	Leaves 2- or 3-lobed, lobes usually entire .. .. .	<i>Lophozia</i>
		Leaves not lobed, toothed, rarely almost entire .. .. .	<i>Plagiochila</i>
26	{	Leaves opposite .. .. .	<i>Southbya</i>
		Leaves alternate .. .. .	27
27	{	Bracts and bracteoles laciniate .. .. .	<i>Jamesoniella</i>
		Bracts entire, bracteoles absent or small .. .. .	28

- 28 { Mouth of perianth contracted, more or less  
       beaked . . . . . *Solenostoma*  
       Mouth of perianth wide . . . . . *Jungermannia*

*Note.*—Many of the thallose genera including *Fossombronia* and *Blasia* can be distinguished very easily. *Riella* is wholly aquatic and is unique in having a dorsal wing. It has so far been found only in Lahore. *Petalophyllum* can readily be distinguished on account of its dorsal lamellæ and apical tubers; also found only in Lahore and along the river bank at Beas. *Sewardiella* and *Fossombronia* are easily recognised by their apical tubers; the former being thallose and the latter possessing beautifully curled leaves. *Blasia* has a superficial resemblance with *Anthoceros* on account of its *Nostoc* colonies but can be easily distinguished by its leaf-like lobes, the ventral scales and the dorsal gemmæ. *Metzgeria* has a distinct midrib with a one-layered wing on each side. *Aneura*, *Pellia*, and *Calycularia* have some resemblance in the sterile condition. In a patch of *Pellia* it is generally always possible to find some sex organs which are always on the main shoot, the antheridia being sunk in pits. In *Calycularia* the antheridia, which here also are on the main shoot, are superficial and accompanied by scaly bracts. *Aneura* has its sex organs on short lateral shoots.

The foliose forms require a more careful investigation before they can be named by the beginner. Among these also several genera can be recognised at sight. *Frullania* is characterised by the possession of bladders in place of the lobules. *Lejeunea* has a saccate lobule which is often represented merely by the incurved postical margin of the lobe. *Madotheca* can be distinguished by the large lobe and the small lobule and conspicuous amphigastria. *Radula* has no amphigastria and the rhizoids arise from the undersurface of the lobule. In *Scapania* and *Diplophyllum* the lobe is smaller than the lobule. The habit of *Plagiochila* is also very peculiar in that the leaves are not complicate and there are no amphigastria.

With a little practice many of the other genera also can be made out readily but a few require the presence of sex organs and the perianth to distinguish them from the allied forms.

## SUBORDER

# ACROGYNÆ.

Gametophyte with stem and two rows of lateral and frequently a third row of ventral leaves (amphigastria). Archegonia usually in a cluster, terminal.

## FAMILY I. LEJEUNEACEÆ.

Leaves alternate, incubous, complicate-bilobed, postical lobe (lobule) small, commonly inflated or saccate. Amphigastria usually present. Rhizoids arising from the base or the middle of the amphigastria. Male shoots (androecia) lateral; antheridia one or two in the axil of each bract. Archegonia terminal, one or more in a cluster. Perianth free from the involueral bracts, 3-12-plicate, rarely terete, the apex constricted into a short tubular beak. Capsule on a short pedicel, globose, 4-valved for  $\frac{2}{3}$  of its length, the lower third solid. Elaters few, monospiral, attached to the inside of the capsule wall by their upper pointed ends, the lower free trumpet-shaped ends reaching the floor of the capsule.

### *Key to the genera.*

Lobule always distinct, galeate, sometimes				
evolute	..	..	..	<i>Frullania</i>
Lobule saccate, sometimes obsolete	..	..	..	<i>Lejeunea</i>

\*            \*            \*            \*            \*

## I. FRULLANIA Raddi.

*Frullania* Raddi, Atti Soc. Ital. Sc. Mod. (1818).

Plants medium, rarely small, green to dark brown, pinnately branched, branches axillary. Leaves imbricate, incubous, almost transversely inserted, complicate-bilobed, antical lobe larger, obliquely ovate to suborbicular, convex, apex decurved, margin entire; lobule cucullate, galeate, occasionally evolute and then

ovate-lanceolate. Amphigastria always present, large, usually smaller than the leaves, base cordate, apex bifid or retuse. Androecia terminal on short lateral branches, rarely hypogynous, narrowly capitate or spicate, bracts closely imbricate, di-androus. Sub-involucral innovations absent. Archegonia 2-4, rarely more, bracts in 2-5 pairs, usually dentate or laciniate, the innermost generally adnate to each other and the bracteole. Perianth tri- or pluri-keeled.

*Note.*—The lobule in several species has a tendency to remain open instead of forming the typical bladders. In such cases the lobule is long and narrow, with revolute margins so that the under-surface is concave.

*Key to the species.*

1	{ Antical base appendaged .. ..	2
	{ Antical base not appendaged .. ..	3
2	{ Leaves distinctly convex on the dorsal side ..	<i>F. Grevilleana</i>
	{ Leaves not convex .. ..	<i>F. squarrosa</i>
3	{ Amphigastria entire or retuse .. ..	<i>F. retusa</i>
	{ Amphigastria bilobed .. ..	4
4	{ Leaves up to 1 mm. long .. ..	<i>F. pyriforma</i>
	{ Leaves up to 0.5 mm. long .. ..	5
5	{ Perianth papillose .. ..	<i>F. gracillima</i>
	{ Perianth smooth .. ..	<i>F. muscicola</i>

*Note.*—Verdoorn has given *Frullania himalayensis* St. and *F. chinensis* St. as synonyms of *F. muscicola* St. (Vide *Symbolæ Sinicæ*, V. Teil., *Hepaticæ*, p. 5, 1930). While naming a specimen of *Frullania* from Mussoorie he says, 'I think *Frull. squarrosa* Nees might be also a form of *F. muscicola* St.' From this it would appear that *F. squarrosa* Nees and *F. muscicola* St. are closely allied and possibly identical. In the latter case all the four species could be reduced to one, i.e. *F. squarrosa* Nees.

**1. *Frullania squarrosa* Nees.**

*Frullania squarrosa* Nees, *Syn. Hep.*, p. 416 (1844).

Dioecious, medium, green to deep brown, epiphytic or terrestrial, in dense depresso-caespitose patches or hanging, pure or

mixed with other foliose forms: Stem 3-4 cm. long, irregularly pinnate. Rhizoids rare, brown, small, arising from the middle of the amphigastria. Leaves oblique, imbricate, spreading, sub-orbicular, 0.7 mm.  $\times$  0.4 mm. to 1.1 mm.  $\times$  0.7 mm., base cordate, antical basal portion distinctly crossing the stem, auricled, auricle reflexed and overlapping the base of the leaf, margin entire or wavy, apex rounded. Upper cells 18  $\mu$ , a few basal cells 45  $\mu \times$  27  $\mu$ , rest smaller; trigones thickened throughout the leaf but more so near the base; walls thick, nodulose, towards the base often uniformly thick. Lobule galeate, mouth narrow or wide, or sometimes evolute, triangular with a blunt apex, about twice as broad as the thickness of the stem. Amphigastria large, about 4 times the lobule and half that of the lobe, very broadly ovate to subrotund, base narrow, margin entire or apical portion toothed, apex bilobed, notch broad, deep, extending to about  $\frac{1}{3}$  of the length, lobes deltoid, acute, rarely the amphigastria entire. Sex organs cladogenous. Androecia capitate, bracts in 3-4 pairs. Involucral bracts usually longer than the leaves; lobe ovate, entire, obtuse; lobule ovate-lanceolate, with margins sparsely toothed, inner strongly so. Bracteoles ovate, deeply bifid, margin dentate, lobes long acuminate. Perianth large, obovate-oblong, depressed below the terminal beak, strongly 3-keeled, often with additional less marked carinae, odd angle postical, carinae dentate, surface more or less papillate. Calyptra free, fleshy, obovate. Seta thin, delicate, up to 5 mm. long; capsule globose, dark brown. Spores yellowish, spherical, areolate, 4-6 areoles in the diam., 25-40  $\mu$ . Elaters yellowish, trumpet-shaped, monospiral, 275-325  $\mu$ , rarely as short as 130  $\mu$ .

Plate I, figures 1-5.

Hab. Moist rocks and bark of trees.

Distrib. Common in the Western Himalayas, especially Garhwal and Kumaon, *Mussoorie*, etc.; *Chamba-Chuari* Road; Nilgiris (Sedgwick).

This is the commonest species of the genus and is met with in most places at about 6,000-7,000 ft.

Note.—Mr. Verdoorn distinguishes one form and one variety (1929, de Frullan. IV, Ann. Bryol. II: 134).



1. *F. squarrosa* fo. *ericioides* (Nees) Verd., distinguished by its evolute lobules which are lanceolate and flat or concave.

2. *F. squarrosa* var. *planescens* Verd., which he characterises as follows :—

Leaves subplane, spreading, amphigastria often large. Postical margin less rounded, large, less cordate. Auricle beaked (beak distinct, frequently curved) or subbeaked.

*Note.*—Typical specimens can be distinguished very readily by the leaf form. The anterior margin of the leaf is usually bent upwards—so that the upper surface becomes depressed and the leaf has a saddle-shaped appearance. In other cases the leaves have a tendency to become flat or even slightly convex on the dorsal side. In the typical form again the leaves are patent whereas in other cases they have a tendency to be arranged at right angles to the stem.

## 2. *Frullania retusa* Mitt.

*Frullania retusa* Mitten, Trans. Linn. Soc., Vol. V, p. 119 (1860).

Sterile, light brown to almost black, on rocks or on bark, in dense extended patches in the former case and hanging down in the latter. Stem about 5 cm. long, irregularly shortly pinnate, pinnae up to 4 mm. long. Rhizoids absent. Leaves more or less imbricate, horizontal, distichous, quadrate-rounded to ovate-oblong, up to 0·9 mm. long and 0·8 mm. broad, antical basal portion crossing over the stem, margin entire, apex rounded, sometimes recurved. Upper cells 20  $\mu$ , basal cells 28  $\mu \times 19$ –23  $\mu$ ; walls and trigones very thick, nodulose. Lobule galeate, anterior margin strongly convex, posterior side concave, rarely evolute. Amphigastria transversely inserted, suborbicular, margin entire, apex retuse, sometimes rounded.

Plate I, figures 6–9.

Hab. On the bark of trees and on rocks.

Distrib. Garhwal, *Mussoorie*; *Dalhousie*.

3. *Frullania muscicola* St.

*Frullania muscicola* St., Hedwigia, 1894, p. 146; Sp. Hep., Vol. IV, p. 444 (1910).

Dioecious, light or brownish green, closely applied to bark. Stem about 1 cm. long, simple or slightly pinnately branched. Rhizoids dark brown. Leaves distant or slightly imbricate, horizontal, suborbicular, 0.7 mm. long and 0.5 mm. broad, sometimes less, base narrow, antical basal portion rounded, crossing the stem, apex rounded or obtuse, recurved. Cells in the greater part of the leaf of the same size, those near the base larger, upper cells  $17\ \mu \times 11-14\ \mu$ , trigones small; basal cells  $26-34\ \mu \times 21\ \mu$ , sometimes only  $17\ \mu$  broad, trigones rather thick; walls nodulose. Lobule on the older parts galeate, on the younger branches often ovate-oblong to oblong with margins rolled back and near the apex sometimes flat. Amphigastria about twice as large as the lobule and about  $\frac{1}{3}$  of the lobe, obovate to suborbicular, apex notched to about  $\frac{1}{4}$  of the length. Androecia ovate. Involucral bracts longer than the leaves; lobule ovate-lanceolate, obtuse, margins revolute. Bracteoles ovate-oblong, bilobed to  $\frac{1}{3}$  at the apex, lobes entire, acute. Perianth obovate, dorsi-ventrally compressed, 4-keeled, keels unequal, smooth all over.

Plate I, figures 10-12.

Hab. Epiphytic.

Distrib. Mussoorie.

4. *Frullania gracillima* St.

*Frullania gracillima* St., Sp. Hep., Vol. IV, p. 437 (1910).

Dioecious, small, slender, generally green, sometimes reddish brown, closely applied to bark. Stem about 1 cm. long, distantly pinnate, pinnæ small. Rhizoids rare, just below the apical notch of the amphigastria. Leaves distant or imbricate, suborbicular, about 0.5 mm. in diameter, base cordate, antical basal portion rounded, covering and crossing the stem, margin entire, apex rounded, recurved. Cells except the few basal ones of the same size, walls thin, sometimes nodulose, trigones small; upper cells  $15-18\ \mu$ , basal cells  $26-30\ \mu \times 17-27\ \mu$ . Lobule galeate, mouth

broad. Amphigastria of the same size as the lobule, obovate, margins entire or sometimes with single cells projecting here and there; apex notched to about  $\frac{1}{3}$ , notch triangular, lobes deltoid, acute. The leaves on the female branches larger and obovate. Bracts ovate-oblong, margin entire, apex rounded or acute; lobule lanceolate, acute, margins entire. Bractéoles quadrate, divided to one half by a narrow slit, lobes acute. Perianth oblong, 6-plicate (all the carinae not well developed) surface papillate, carinae denticulate.

Plate I, figures 13-15.

Hab.— On bark of trees.

Distrib. Outer Himalayas, *Chamba*; *Murree*; Garhwal.

Note.—The leaves on some of the branches towards the upper end sometimes remain very small so that these branches look like flagellæ.

The leaves are usually convex on the dorsal side. Occasionally, however, they are directed slightly upwards, just showing a slight resemblance to the condition met with in *F. squarrosa*.

The perianth has two small ventral keels, two large lateral keels and generally three dorsal keels, the two dorso-lateral keels being very small.

##### 5. *Frullania pyriflora* St.

*Frullania pyriflora* St., Sp. Hep., Vol. IV, p. 443 (1910).

Diœcious, small, light green to deep brown, closely applied to bark. Stem about 1.5 cm. long, irregularly pinnate. Rhizoids from the base of the amphigastria. Leaves distant to slightly imbricate, patent, suborbicular, 0.75-1 mm.  $\times$  0.5-0.75 mm., antical basal portion rounded, covering and crossing the stem, margins entire, apex broad, rounded. Upper cells 15  $\mu$ , median cells 24-28  $\mu$  and basal cells 30-32  $\mu$  in diameter, some elongated and longer; walls thin, slightly thick near the base, trigones slightly thick. Lobule large, about one and a half times as broad as the stem, strongly galeate, mouth truncate or often near the apex of the shoot oblong with margins rolled back. Amphigastria small, somewhat broader than the stem, obovate to obovate-oblong, divided to about  $\frac{1}{3}$  the length, notch obtuse, lobes acute. Andrœcia

spicate, oblong. Bracts broadly obovate, about twice as large as the leaves; lobule lanceolate, free, entire, but with a tooth towards the bracteole. Bracteoles obovate-oblong, with a tooth at the middle on each side, apex bifid up to the middle, sinus acute, lobes lanceolate, acute. Perianth pyriform, dorsally triplicate, ventrally biplicate, smooth.

Plate II, figures 1-3.

Hab. On bark.

Distrib. *Khajiar* (beyond *Dalhousie*), 6,000 ft.; *Masrund* (Chamba State), 4,000 ft.; Kashmir.

*Note*.—Some specimens from *Dalhousie* are separated by Mr. Verdoorn as var. *Kashyapii*. These plants are more delicate, the leaves are more transparent and the lobule is evolute practically all over the plant. The perianth is rather compressed and has five ridges, of which the two ventral ones are small, the two lateral ones are the largest, and the third median dorsal is the smallest.

## 6. *Frullania Grevilleana* Tayl.

*Frullania Grevilleana* Taylor, Syn. Hep., p. 421 (1844).

Dioecious, large, reddish purple. Stem about 6 cm. long, bipinnate, pinnae regular, alternating, 5-8 mm. long, more or less attenuated. Leaves imbricate, patent-divergent, convex, ovate-elliptical, 1 mm.  $\times$  0.75 mm., antical base covering and crossing the stem, rounded, appendaged, appendage narrow, entire, decurrent, margin entire, apex rounded. Upper cells 12-20  $\mu$ , trigones thick, walls also thickened; basal cells 32-40  $\mu \times$  16  $\mu$ , trigones and walls thick. Lobule narrow, more or less appressed to the stem, twice as long as broad, mouth oblique, truncate. Amphigastria large, broadly ovate, base deeply cordate, margin entire, recurved, apex notched to about  $\frac{1}{5}$ , notch acute, lobes obtuse. Androecia capitate. Perianth and bracts not seen.

Plate II, figures 4-7.

Hab. Terrestrial and epiphytic.

Distrib. *Kidar Kanta* (Duthie, 1879); *Kurseong*, Sikkim (Bretaudau, 1894), (Herb., F.R.I., Dehra Dun).

*Note.*—The West Himalayan plants are terrestrial growing among mosses. They are smaller and compact; but the Sikkim specimens are epiphytic, larger and lax.

The following species of *Frullania* are described by Stephani but have not been seen by us.

#### 7. *Frullania Gollani* St.

*Frullania Gollani* St., Sp. Hep., Vol. IV, p. 445 (1910).

Sterile, olive green, flaccid, on bark. Stem up to 3 cm. long, shortly and remotely pinnate. Leaves slightly imbricate or contiguous, strongly spreading, plano-distichous, ovate-elliptic, 0.8 mm.  $\times$  0.65 mm., apex broadly rotundate, antically broadly covering the stem, antical base rotundate, appendiculate. Upper cells 18  $\mu$ , basal 27  $\mu \times$  18  $\mu$ , trigones large, walls rigid. Lobule large, twice as broad as the stem, contiguous, erect, symmetrical, about twice as long as broad, apex truncate-rotundate, constricted below the mouth, mouth also truncate. Amphigastria large, transversely inserted, obovate-obcuneate, angular on both sides, apex about  $\frac{1}{2}$  inciso-bilobed, sinus pretty straight, lobes triangular acute.

Hab. Himalaya, Simla.

#### 8. *Frullania himalayensis* St.

*Frullania himalayensis* St., Sp. Hep., Vol. IV, p. 441 (1910).

Dioecious, medium, dark brown, dense depresso-cæspitose. Stem up to 4 cm. long, irregularly branched, primary branches 2 cm. long, mixed with smaller branches, irregularly shortly pinnate, sometimes bipinnate. Leaves imbricate, spreading, broadly obovate, antically covering the stem, antical base circinate-appendaged. Upper cells 18  $\mu$ , basal 36  $\mu \times$  27  $\mu$ , trigones large, at the base larger. Lobule large, twice as broad as the stem, strongly cucullate, slightly longer than broad, lightly nodding, apex obtuse, mouth truncate. Amphigastria large, about thrice as broad as the stem, transversely inserted, subrotund, apex about  $\frac{1}{4}$  exciso-bilobed, sinus wide, lobes triangular, obtuse. Female inflorescences terminal on short branches. Involucral bracts in three pairs, obovate, apex rounded; lobule slightly smaller, broadly

lanceolate, deeply canaliculate-concave, entire, acute. Bracteoles free, ovate-oblong, about  $\frac{2}{3}$  inciso-bifid, notch narrow, lobes lanceolate, spreading, acuminate, acute, entire.

Hab. Himalaya (*Mussoorie*).

*Note*.—We have not seen the plants described by Stephani but from his description *F. himalayensis* St. does not appear to be specifically distinct from *F. squarrosa* Nees and is very likely a form of the same.

### 9. *Frullania Duthiana* St.

*Frullania Duthiana* St., Sp. Hep., Vol. IV, p. 351 (1910).

Dicecious, small, deep brown, rigid, among mosses. Stem up to 2 cm. long, deep brown, sparsely shortly pinnate. Leaves patent, strongly concave, apex broadly decurved, broadly obovate, 0.86 mm. long. Upper cells  $18\ \mu$ , basal  $36\ \mu \times 18\ \mu$ , trigones large, acute. Lobule small, about as broad as the stem, more or less strongly cucullate, mouth oblique, truncate, compressed, narrow, distinctly but briefly coalesced with the lobe. Amphigastria almost as large as the leaves, circular, base deeply cordate, apex entire. Involucral bracts close, twice as long as the leaves, ovate, obtuse, entire. Bracteoles small, obcuneate, free, about  $\frac{1}{2}$  inciso-bilobed, lobes lanceolate, acute.

Hab. Himalaya (*Kidar Kanta*).

\* \* \* \* \*

## II. LEJEUNEA Libert.

*Lejeunea* Libert, Ann. Gen. Sc. Phys. 6, p. 372 (1820).

Plants minute and delicate, medium, or large and robust. Stem pinnately branched. Leaves alternate, complicate-bilobed, incubous, oblique or almost longitudinally inserted, margin entire or more or less toothed. Lobule inserted in the same plane, incurved or ventricose, rarely plane or obsolete. Amphigastria entire or bifid, rarely absent. Monœcious or dicecious. Androecia usually on short branches, occasionally on the main stem; bracts

subequilobed, di-androus, in rare cases tri-androus or mon-androus. Female branch with a single archegonium; usually with sub-involucral innovations. Bracts more or less different from the stem leaves, one to several pairs; bracteoles about the same size. Perianth free from the bracts, plicate, rarely perfectly terete, sub-cylindrical or plano-compressed, usually pyriform, frontally compressed; angles smooth or variously armed, apex usually produced into a beak. Capsule pedicellate, globose, hyaline or pale brown, dividing to about  $\frac{2}{3}$  into four valves; wall of two layers of cells, inner spongy. Elaters fixed to the apex of the valves, mono-spiral.

The genus *Lejeunea* (in the wide sense) is nowadays usually split up into a large number of sub-genera or genera. Since the number of species included here is very small it has been thought best to put them in the genus *Lejeunea* in the comprehensive sense, especially as most of them are met with generally only in the sterile condition. The narrower generic name is given within brackets.

*Key to the species.*

- |   |  |                       |
|---|--|-----------------------|
| 1 | { Amphigastria absent, lobule flat .. ..           | Sp. E.                |
|   | { Amphigastria present, lobule saccate .. ..       | 2                     |
| 2 | { Amphigastria not bilobed (Holostipæ), plants     |                       |
|   | { medium or large .. ..                            | 3                     |
|   | { Amphigastria bilobed (Schizostipæ), plants small | 5                     |
| 3 | { Leaves very closely imbricate .. ..              | Sp. A.                |
|   | { Leaves not very closely imbricate .. ..          | 4                     |
| 4 | { The apex of the lobe and the amphigastrium       |                       |
|   | { with several teeth .. ..                         | <i>L. Perrottetii</i> |
|   | { The apex of the lobe and the amphigastrium --    |                       |
|   | { entire .. ..                                     | <i>L. chinensis</i>   |
| 5 | { Lobule with a tooth on the anterior margin ..    | Sp. D.                |
|   | { Lobule without a tooth on the anterior margin    | 6                     |
| 6 | { Leaves large, slightly overlapping, more or less |                       |
|   | { crisped .. ..                                    | Sp. C.                |
|   | { Leaves smaller, closely overlapping, flat ..     | Sp. B.                |

10. *Lejeunea* (*Ptychanthus*) *Perrottetii* St.

*Ptychanthus Perrottetii* St., Hedw., 1896, p. 121; Sp. Hep., Vol. IV, p. 750 (1912).

Dicecious, large, robust, green or brown, in dense patches on rocks, or bark of trees. Stem procumbent, more or less regularly repeatedly pinnate, 15 cm. or more long; pinnæ 1-3 cm. long. Rhizoids absent. Leaves imbricate, horizontal, oblique, oblong-ovate, up to 1.5 mm.  $\times$  1 mm., insertion narrow, antical base rounded, covering and crossing the stem, appendaged, appendage rounded and not sharply marked off, postical slightly decurrent, antical margin convex, postical margin revolute, subapical portion of the postical margin and often of the antical margin also with a few 1-celled teeth, occasionally the whole margin entire, apex acute, often acuminate, or rarely obtuse or rounded. Upper and median cells 12-18  $\mu$  in diameter, walls and trigones somewhat thickened, conspicuous; basal cells 32-54  $\mu \times$  22-30  $\mu$  (usually 45  $\mu \times$  27  $\mu$ ), walls thick, trigones large, nodulose. Lobule saccate, minute, twice as long as broad, not toothed, often obsolete. Amphigastria large, a little more than twice as broad as the stem, quadrate, base cordate, more or less parallel to the stem, not much spreading, margins entire, often somewhat irregular, apex broad, truncate, with numerous 1-celled teeth, occasionally, entire. Androecia intercalary, ovate-oblong; bracts about 6 pairs, lobule well-developed,  $\frac{2}{3}$  as long as the lobe and about  $\frac{1}{2}$  as broad; amphigastria small, entire. Female inflorescence cladogenous, unilaterally innovating, innovations simple or once floriferous. Involucral bracts and bracteoles like the leaves and the amphigastria, bracteoles rather long. Perianth pyriform, much narrowed below, pluriplicate, carinæ smooth, inflated, mouth beaked. Elaters laxly monospiral, 320-370  $\mu$ . Spores light yellowish, finely punctate, 30  $\mu$  in diameter.

Plate II, figures 8-12.

Hab. On rocks and bark of trees.

Distrib. Garhwal; Kumaon, 6,000-7,000 ft. Very common.

Common also in Eastern Himalayas, Darjeeling, etc.

Note.—The plant varies very greatly as regards the margin of the leaf; generally there are several teeth near the apex of the



lobe and that of the amphigastrium, sometimes the apex ends in a single tooth, occasionally there is no trace of any teeth on the lobe or the amphigastrium, the whole margin is absolutely entire, the apex of the lobe is rounded, and that of the amphigastrium is truncate.

## 11. *Lejeunea (Ptychanthus) chinensis* St.

*Ptychanthus chinensis* St., Sp. Hep., Vol. IV, p. 744 (1912).

Dioecious, medium, light green or brownish, up to about 5 cm. long, regularly pinnate and irregularly bipinnate. Leaves oblique, horizontal, distichous, imbricate, oblong-ovate, up to 1.5 mm.  $\times$  1 mm., antical base rounded, covering and slightly crossing the stem, postical decurrent, margins entire, antical convex, postical revolute, markedly concave in the natural condition but quite straight when the leaves are spread out, apex rounded or obtuse. Upper cells 14–18  $\mu$ , basal cells 36–43  $\mu \times$  25–28  $\mu$ ; trigones large, conspicuous, walls thick, occasionally nodulose. Lobule obsolete. Amphigastria distant, spreading (not appressed), suborbicular to reniform, inserted by a notched base, entire, rounded or retuse. Androecia intercalary, ovate to oblong-ovate, bracts 4–6 pairs, smaller than the leaves, lobule large, strongly saccate; amphigastria a little longer than those on the vegetative parts. Female inflorescence unilaterally innovating, innovation once floriferous. Bracts like the leaves, bracteoles large, more or less oblong or obovate-oblong. Perianth oblong-ob lanceolate, narrowed at the base, pluri-plicate, carinae smooth.

Plate II, figures 13–15.

Hab. - On rocks.

Distrib. *Almora* and *Mussoorie*.

*Note.*—The plant is very similar in habit to the foregoing species, *L. Perrottetii*; and sometimes occurs mixed with it. It is distinguished from that species by the absolutely entire leaves and the amphigastria; there being no trace of any teeth anywhere, and the markedly concave postical margin of the lobe in nature. The amphigastria also in this species are more spreading, bending away from the stem.

12. *Lejeunea* Sp. A.

Diœcious, light green, closely attached to bark. Stem about 3 cm. long, irregularly bipinnate. Rhizoids short, brown, in tufts from the bases of the amphigastria. Leaves closely imbricate, orbicular-obovate, with a very narrow base, convex above, about 1 mm. long  $\times$  1 mm. broad, antical base appendaged, covering and very much crossing the stem, margins entire, apex rounded. Upper cells  $32\ \mu \times 20\ \mu$ , basal cells larger,  $40\text{--}60\ \mu \times 29\text{--}36\ \mu$ , walls rather thin, sometimes somewhat nodulose, trigones thickened, acute. Lobule very much inflated through its greater part, anterior part flat, quadrate-oblong, margin entire, apex truncate. Amphigastria large, suborbicular, rather broader than long, margin entire, apex rounded, slightly revolute. Subinvolucral innovations two, equally or unequally developed, or only one, not floriferous. Bracts and bracteoles like the leaves but larger; lobule flat. Perianth obovoid, pluriplicate, carinæ smooth, beak not prominent. Seta 2 mm. long, pellucid. Spores  $60\text{--}65\ \mu$ , golden yellow, mammillate and echinate, winged, wing  $4\ \mu$ , crenulate. Elaters concolorous, laxly monospiral, spiral broad,  $400\text{--}560\ \mu$ .

Plate III, figures 1-7.

Hab. Closely attached to bark, often mixed with *Frullania squarrosa* and others.

Distrib. Almora, 6,000 ft.; Garhwal, Mussoorie, 6-7,000 ft.

Note.—The plant can be easily distinguished by its habit, being closely applied to bark, and its closely imbricate entire leaves.

13. *Lejeunea* Sp. B.

Sterile, small, light green or whitish green, in dense tufts. Stem pauci-pinnate, 5-6 mm. long. Leaves imbricate, planodistichous, suborbicular, up to  $0.33\text{ mm.} \times 0.25\text{ mm.}$ , base as broad as the stem, almost flat, antical basal portion rounded, covering the stem, margins entire, apex rounded. Cells rectangular, polygonal or circular, walls and trigones slightly and equally thickened, often trigones indistinct; marginal cells smaller, upper cells  $16\ \mu \times 12\ \mu$ , median cells  $18\ \mu$ , basal a little larger,  $24\ \mu \times 18\ \mu$ . Lobule ovate,  $0.12\text{ mm.} \times 0.08\text{ mm.}$ , inflated, often

very small and rarely obsolete. *Amphigastria* imbricate, sub-orbicular, margin entire, apex about  $\frac{1}{2}$  bifid, lobes acute, converging at the apex. Perianth obovate-oblong, 5-carinate, surface and carinæ smooth.

Plate III, figures 8-11.

Hab. On rocks and bark.

Distrib. Garhwal; Western Himalaya; Simla; Khajiar  
Mussoorie.

#### 14. *Lejeunea* Sp. C.

Sterile, small, delicate, in dense tufts of prostrate plants on rocks. Stem pellucid, simple or with a few branches, 6-12 mm. long. Leaves distant or only slightly imbricate, patent, convex, often crisped, oblique-ovate, up to 0.7 mm.  $\times$  0.6 mm., base narrow, clasping half the stem, antical basal portion rounded, covering and slightly crossing the stem; margin entire, apex rounded. Upper cells 18  $\mu$ , median cells 25  $\mu$ , basal cells 29-36  $\mu$ ; walls thin, trigones slightly thickened, distinct. Lobule equilateral-triangular, 0.13 mm.  $\times$  0.13 mm. *Amphigastria* twice as broad as the stem, sub-orbicular, entire, about  $\frac{1}{2}$  bifid, lobes acute, converging at the apex. Rest not seen.

Plate IV, figures 1-4.

Hab. On rocks.

Distrib. Kumaon; Simla, 6-7,000 ft.; Khajiar, 6,000 ft.  
Alwas-Sitrundi Road, 8-10,000 ft.; Garhwal,  
Mussoorie, 6-7,000 ft.

*Note.*—Resembles *Lejeunea* B. very much, but can be distinguished on account of its fewer branches, and more lax leaves, which are also generally larger, less overlapping, and often wavy. The leaves in the former species are almost flat and much smaller. Occasionally the leaves in this species also are very small. In both the species there is a constriction (something like a notch) at the junction of the lobe and the lobule at the margin. Probably the two are not specifically different. The reproductive organs are, however, not known in this species and the two may be kept separate provisionally.

15. *Lejeunea* Sp. D.

Dioecious, small. On rocks and bark, mixed with *Pt. Perrottetii* and others. Stem irregularly and slightly branched, about 10 mm. long. Leaves distant or slightly overlapping, patent or almost horizontal, distichous, oblique, slightly convex on the dorsal side, ovate-oblong, 0.5 mm. long and 0.3 mm. broad, margin entire, apex rounded. Walls thin, trigones indistinct or absent; upper cells 18  $\mu$ , median cells 35  $\mu \times 25 \mu$  or polygonal with a diameter of 25  $\mu$ , basal cells like the median cells. Lobule inflated, 0.15 mm. long and 0.12 mm. broad, nearly triangular, anterior margin with a more or less distinct tooth at its outer end at a distance of 0.05 mm. from its junction with the postical margin of the leaf. Amphigastria  $2\frac{1}{2}$  times the thickness of the stem, distant, suborbicular, about  $\frac{1}{2}$  bifid, lobes triangular, more or less divergent, subacute or obtuse. Andrœcia on short branches, subcapitate, flattened, bracts about 4 pairs. Perianth obovate, beak conspicuous, 5-plicate, upper surface flat, ventral with two or three small keels, the two lateral keels largest, surface and carinæ smooth. Subfloral innovation single, fertile.

Plate IV, figures 5-7.

Hab. On rocks and bark.

Distrib. Garhwal; *Mussoorie*.

*Note.*—This species in its typical form can be easily distinguished from the two foregoing species by the presence of a tooth on the anterior margin of the lobule. The tooth, however, is sometimes very small; on the same branch some lobes may have a very distinct tooth, in others the tooth may be very faint or even wholly absent. It can also be distinguished by the divergent lobes of the amphigastria; the lobes are usually divergent but occasionally they are more or less convergent.

16. *Lejeunea* (*Physocolea*) Sp. E.

Monœcious, small, closely pressed on bark, delicate, pale greenish yellow to dark brown, mixed with other hepatics. Stem branched, about 12 mm. long. Leaves slightly or not at all imbricate, horizontal, oblique, broadly ovate to ovate-orbicular,

up to 1.0 mm. long and up to 0.75 mm. broad, inserted by a narrow non-decurrent base, margins entire, apex rounded. Upper cells 14–18  $\mu$ , median 18–25  $\mu$ , basal 40–45  $\mu \times 30 \mu$ , walls and trigones thin. Lobule deltoid, up to 0.33 mm. long and 0.1 mm. broad, margin entire, apex rounded. Amphigastria absent. Androecia spicate, oblong, bracts 6 to 8 pairs. Female inflorescence with one sub-involucral innovation, innovation repeatedly floriferous. Bracts like the leaves; bracteoles absent. Perianth pyriform, compressed, dorsal with or without one faint carina, ventral with two or three faint carinæ, lateral wings conspicuous. Mouth beaked when young, but later on becoming bilabiate. Capsule long exserted, opening by 4 valves up to  $\frac{2}{3}$ , lower part solid.

Plate IV, figures 8–11.

Hab. On bark.

Distrib. *Mussoorie*.

*Note*.—The plant is very near *Ph. madothecoides* St. (Sp. Hep., Vol. V, p. 898) and *Ph. producta* (Mitt.) St. (Sp. Hep., Vol. V, p. 902).

The following species of *Ptychanthus* is reported by Mitten (Jour. Proceed. Linn. Soc., Vol. V, p. 109) from Kumaon but we have not seen it. The description is after Stephani (Sp. Hep., Vol. IV, p. 753).

#### 17. *Ptychanthus striatus* (L. et L.) Nees.

*Ptychanthus striatus* (L. et L.) Nees, Hep. Eur. III, p. 212.

Monœcious, large, light brown, rigid, hanging from the branches of trees. Stem up to 20 cm. long, regularly bipinnate, primary branches up to 4 cm. long, spread out, shortly and sparsely pinnulate. Leaves contiguous, strongly spreading, slightly concave, postical margin narrowly incurved, broadly ovate, subsymmetrical (2.4 mm. long, in the middle 1.6 mm. broad), apex acute, strongly toothed below the apex, inserted by a narrow base, antical base coarsely rotundate-appendiculate. Upper cells 27  $\mu \times 18 \mu$ , trigones large; basal cells 36  $\mu \times 18 \mu$ , walls interruptedly trabeculate. Lobule small,  $\frac{1}{4}$  the lobe, invisible *in situ*, oblong, apex half as broad as the base, oblique-truncate, angle acute. Amphigastria large, breadth 4 times the thickness of the stem, subrotund, inserted by

a notch, base cordate, ampliate. Perianth clavate, thrice as long as broad, 10-plicate, carinæ inflated, beak long. Bracts slightly smaller than the leaves, similarly armed; lobule narrow,  $\frac{1}{3}$  of the lobe, oblong, apex shortly truncate, acute. Bracteole as long as the bracts, obovate, apex broadly emarginate, angle acute. Andrœcia more or less spicate, bracts 6-15 pairs.

Hab. Bark of trees.

Distrib. Kumaon (Strachey and Winterbottom); Nepal (Wallich); Sikkim, 7-10,000 ft. (J. D. Hooker); Khasia (J. D. H. and T. T.); Assam (Simons, Griffith).

## FAMILY II. MADOTHECACEÆ.

Plants large. Stems usually regularly bi- or tri-pinnate. Rhizoids scarce, arising from the base of the amphigastria. Leaves incubous, complicate-bipartite almost to the base, antical lobe large; postical (lobule) flat, much smaller, nearly parallel to the stem. Amphigastria resembling the lobules but broader, frequently decurrent at the base. Andrœcia short, lateral, bracts nearly equally bilobed, opposite; antheridia solitary. Archegonial cluster terminal on very short lateral branches; bracts usually a single pair. Perianth suboval, more or less compressed dorsi-ventrally in the anterior portion, mouth becoming bilabiate or campanulate by the extrusion of the capsule. Calyptra of several layers of cells. Capsule shortly pedicellate, globose, 4-valved, the valves often irregularly split and rarely separating down to the base. Elaters short, 2-3-spiral.

## III. MADOTHECA Dum.

*Madotheca* Dum., Comm. Bot., p. 111 (1822).

*Porella* Dill., Hist. Musc., p. 459 (1741)?; Lindb. in Act. Soc. Sc. Fenn., p. 329 (1869).

*Bellincinia* et *Antoiria* Raddi in Mem. Soc. Ital. Mod. 18 pp. 18, 19 (1820).

Only genus in the family. Characters of the family.

*Key to the species.*

- |   |   |  |                         |
|---|---|--|-------------------------|
| 1 | { | Margin of the lobe toothed in the upper part,                              |                         |
|   |   | or only acute (acutifoliæ) .. ..   | 2                       |
|   | { | Margin of the lobe entire (obtusifoliæ) .. ..                              | 7                       |
| 2 | { | Inner base of the lobule longly decurrent along                            |                         |
|   |   | the stem .. ..   | 3                       |
|   | { | Inner base of the lobule not decurrent .. ..                               | 4                       |
| 3 | { | Outer base of the lobule appendaged .. ..                                  | <i>M. appendiculata</i> |
|   | { | Outer-base not appendaged .. ..  | <i>M. Gollani</i>       |
| 4 | { | Lobe apex simply acute, margin strongly                                    |                         |
|   |   | twisted .. ..  | <i>M. acutiphylla</i>   |
|   | { | Lobe apex broad, with teeth .. ..  | 5                       |
| 5 | { | The lobe, lobule and amphigastria coarsely                                 |                         |
|   |   | toothed .. ..  | <i>M. denticulata</i>   |
|   | { | The lobe with small teeth, the lobule and                                  |                         |
|   |   | amphigastria entire or with a few teeth .. ..                              | 6                       |
| 6 | { | Lobes with numerous teeth, amphigastria                                    |                         |
|   |   | large .. ..  | <i>M. campylophylla</i> |
|   | { | Lobes with 1-3 teeth, amphigastria small .. ..                             | <i>M. plumosa</i>       |
| 7 | { | Plants delicate, lobe entire, rarely with 1 or 2                           |                         |
|   |   | teeth, lobule and amphigastria small, distant .. ..                        | * <i>M. variabilis</i>  |
|   | { | Plants not so delicate, lobes never toothed,                               |                         |
|   |   | lobule and amphigastria quite large, approximate .. ..                     | 8                       |
| 8 | { | Antical basal portion decurrent on the stem .. ..                          | 9                       |
|   | { | Antical basal portion not decurrent .. ..                                  | 11                      |
| 9 | { | Lobule appendaged on both sides of the base .. ..                          | 10                      |
|   | { | Lobule decurrent on the inner base, not appendaged at the outer base .. .. | <i>M. Gambleana</i>     |

\* Sometimes the apex of the lobule has got 1 or 2 faint teeth and the amphigastria are large, toothed at the apex or at the base also.

- |    |   |  |                       |
|----|---|--|-----------------------|
| 10 | { | Lobe ovate, antical basal portion rounded      |                       |
|    |   | and slightly crossing the stem ..              | <i>M. platyphylla</i> |
|    | { | Lobe broadly ovate, antical basal portion much |                       |
|    |   | larger and crossing far beyond the stem ..     | <i>M. decurrens</i>   |
| 11 | { | Lobule very large ..                           | <i>M. macroloba</i>   |
|    |   | Lobule smaller ..                              | 12                    |
| 12 | { | Postical base decurrent on the stem, antical   |                       |
|    |   | crossing far beyond the stem ..                | <i>M. gracillima</i>  |
|    | { | Postical base not longly decurrent, antical    |                       |
|    |   | not or only slightly crossing the stem ..      | <i>M. obtusifolia</i> |

### 18. *Madotheca appendiculata* St.

*Madotheca appendiculata* St., Sp. Hep., Vol. IV, p. 301 (1910).

Large, flaccid, light or deep green, on rocks. Stem up to 15 cm. long, regularly 2-4-pinnate. Leaves imbricate, horizontal, oblique-ovate-oblong, up to 2 mm. long and 1.25 mm. at the broadest point, antical base ampliate, rounded, covering the stem and often slightly crossing it, decurrent on the stem, wing linear acute, postical base wavy, margins entire, apex acute, acuminate or bi- or tri-dentate. Upper cells 15-22  $\mu$  (mostly 18  $\mu$ ), walls and trigones equally thickened; basal cells 40-47  $\mu \times$  21-27  $\mu$  (some smaller), walls thinner, trigones large, sometimes nodulose. Lobule large, oblong to ovate-oblong, 1.0 mm.  $\times$  0.5 mm., slightly imbricate, appendaged on both sides of the base, appendages crisped, apex rounded or obtuse. Amphigastria shorter and broader than the lobules, 0.75 mm. long and 0.75 mm. at the broadest point, fixed by a broad sinus, unequally decurrent on both sides, margin crisped in the lower part, apex rounded, reflexed. Involucral bracts slightly narrower than the leaves, margins spinous. Bracteoles ovate to quadrate, larger than the amphigastria, margin entire or toothed, apex broad spinous. Perianth large, campanulate, divided irregularly into a number of lobes, lower portion of the lobes toothed, upper with long spinés. Spores golden-yellow, muriculate, 47-55  $\mu$ . Elaters concolorous, long or short, bi- or tri-spiral, spiral lax, broad, 220-240  $\mu$  (some only 133  $\mu$ ).



Plate V, figures 1-7.

Hab. On rocks.

Distrib. Pangi, Kilar-Sach Road; Dalhousie; Mussoorie.

### 19. *Madotheca campylophylla* L. et L.

*Madotheca campylophylla* L. et L., Syn. Hep., p. 265 (1844).

*Jungermannia campylophylla* L. et L. in Lehm. Pug. 6, p. 40 (1834).

*Jungermannia neckeroides* Griff., Notulæ 1849 c. icone.

Large, brownish green, stem shortly pinnate. Leaves distant or slightly imbricate, horizontal, oblong or ovate-oblong, up to 2.25 mm.  $\times$  1.50 mm., base broad, antical basal portion entire, rounded, covering the stem, anterior margin entire, convex, posterior slightly twisted, lower part concave, apex usually acute or long acuminate, subapical portion with several coarse teeth. Upper cells 18-27  $\mu$ , basal cells 72  $\mu \times$  30  $\mu$ ; walls thin in the upper part, thick in the lower part, trigones conspicuous in the lower part. Lobule ligulate, up to 0.50 mm. long and 0.25 mm. broad, usually smaller, outer base entire, inner base decurrent, margin entire, apex rounded or obtuse. Amphigastria slightly larger than the lobules, ovate, ovate-oblong or subquadrate, unequally decurrent on both sides of the base; margin entire, apex reflexed, acute, truncate, retuse or pluridentate. Bracts about half the size of the leaves, lanceolate, entire or subapically dentate, obtuse or acute; lobule broadly ligulate, almost entire, obtuse or truncate. Bracteoles oblong, almost entire, blunt, unequally bilobed, one lobe often obsolete, the other lobe acuminate.

Plate V, figures 8-11.

Hab. On rocks.

Distrib. Mussoorie, 6-7,000 ft. (Duthie, 1895); Kurseong (Sikkim) 5,000 ft. (Bretaudié, 1894) (Herb., F.R.I., Dehra Dun); Garhwal, Kauria, 7,000 ft.

### 20. *Madotheca Gollani* St.

*Madotheca Gollani* St., Sp. Hep., Vol. IV, p. 304 (1910).

Large, deep green, on rocks or bark. Stem up to 10 cm. long, irregularly pinnate, long branches mixed with short branches and

bi- or even tri-pinnate. Leaves slightly imbricate, horizontal, ovate-oblong to lanceolate, up to 2.50 mm.  $\times$  1.25 mm., inserted by a narrow base, antical basal portion entire, rounded, covering and often slightly crossing the stem, postical not decurrent, anterior margin convex, posterior twisted, concave in the lower part and bent upwards in the upper part, margins entire throughout the greater part, subapical portion usually coarsely toothed, apex usually with a long spine, often only acute. Upper cells 20  $\mu$ , walls and trigones equally thickened; basal cells 47-53  $\mu \times$  29-33  $\mu$ , walls slightly thickened, trigones large, prominent. Lobule narrow, oblong-ligulate to linear, 0.75 mm. long and 0.25 mm. broad, inner base decurrent on the stem, margin entire, apex rounded, truncate or bidentate. Amphigastria about the same size as the lobules, ovate or subrectangular, base slightly decurrent on both sides, margins entire, apex truncate or bidentate. Bracts like the leaves but much smaller, long acuminate, coarsely toothed to lacerate in the upper part; lobule also coarsely toothed to lacerate at the apex. Bracteoles large, broadly ovate, more or less entire.

Plate VI, figures 1-5.

Hab. On rocks and bark.

Distrib. Garhwal, above *Kauria*, 7,000 ft., *Mussoorie*; *Dalhousie-Khajiar* Road.

*Note*.—Resembles *M. appendiculata*. It can be distinguished by the posterior twisted margin of the leaf. In the other species the margin is simply convex. Moreover the lobule in *M. appendiculata* is appendaged on both sides.

The specimens from *Dalhousie-Khajiar* Road have more numerous and coarser teeth in the upper part of the leaf. Even the lower part of the anterior margin has a few teeth. Some plants show a peculiarity in that their basal branches have absolutely entire suborbicular leaves which gradually become longer and the teeth also become gradually coarser in the upper part.

## 21. *Madotheca plumosa* Mitt.

*Madotheca plumosa* Mitt., Jour. Proc. Linn. Soc., Vol. V, p. 108 (1860).

Light green. Stem about 6 cm. long, shortly and irregularly pinnate, some pinnæ 1-2 cm. long, others longer and again pinnate. Leaves more or less imbricate, almost horizontal, ovate-oblong, up to 1.25 mm.  $\times$  0.75 mm., base narrow, antical basal portion entire, rounded, covering but not crossing the stem, anterior margin convex, posterior twisted, entire or with a few teeth, apex generally acute, rarely obtuse, occasionally with two or more teeth. Upper cells 20  $\mu$ , basal cells (only a few of the largest cells) 48-52  $\mu \times$  20-26  $\mu$ ; walls thin, trigones acute, conspicuous. Lobule small, ovate to ovate-oblong, up to 0.3 mm. long and 0.2 mm. broad, inner base auriculate, margin entire, apex obtuse. Amphigastria slightly larger than the lobules, ovate-oblong, base broad, margin entire, apex truncate or retuse bilobed. Bracts smaller than the leaves, ovate to ovate-lanceolate, acute or acuminate, lobules and amphigastria (bracteoles) similar but smaller.

Plate VI, figures 6-10.

Hab. Terrestrial or epiphytic.

Distrib. *Mussorie*; *Dalhousie*; *Chamba*, 4,000 ft.

*Note.*—There is a specimen of this species at the herbarium of the Forest Research Institute, Dehra Dun, labelled *M. plumosa* Mitt. and determined by Stephani. The description given in Stephani, Sp. Hep., Vol. IV, p. 308, however, differs in several respects from the above description which has been drawn up from the Dehra Dun specimens and other plants from our own Himalayan collection.

## 22. *Madotheca denticulata* Sp. Nov.

Light green, on rocks. Stem about 5 cm. long, 2-3-pinnate, pinnæ long. Leaves slightly imbricate, horizontal, ovate to oblong, up to 2.0 mm.  $\times$  1.25 mm., base narrow; antical basal portion entire, rounded, covering but not crossing the stem, postical decurrent, margins wavy, antical margin convex, posterior twisted, lower part concave, incurved, apex and the upper portion of the margins with several long or short spreading teeth. Upper cells 27  $\mu$ , basal up to 50-55  $\mu \times$  27-40  $\mu$ ; walls thin and narrow, trigones large. Lobule linear-oblong, 1.0 mm. long and 0.25 mm.

broad, inner base longly decurrent on the stem, margin and apex irregularly toothed, rarely entire. Amphigastria a little broader, ovate-oblong, unequally and longly decurrent on both sides of the base, margin and apex irregularly and coarsely toothed. Female shoots (only young seen) substipitate. Bracts like the leaves; bracteoles like the amphigastria but much smaller.

Plate VII, figures 1-4.

Hab. On rocks.

Distrib. *Dalhousie-Khajiar* Road, 6-7,000 ft.

### 23. *Madotheca acutiphylla* Sp. Nov.

Brownish green, dense, depresso-caespitose, on rocks. Stem about 6 cm. long, rigid, dark brown, bi- to tri-pinnate. Leaves imbricate, patent-divergent to horizontal, oblique, ovate, 2.0 mm.  $\times$  1.25 mm., base narrow, antical basal portion decurrent, covering but scarcely crossing the stem, postical decurrent, margins entire, crisped, anterior slightly convex, posterior straight when flattened, apex usually acute, rarely bidentate or obtuse. Upper cells 24-30  $\mu$ , basal cells up to 60  $\mu \times$  27  $\mu$ ; walls rather thickened, trigones small in the upper part, larger in the basal part. Lobule linear, 0.50 mm. long and 0.13 mm. broad, falcate, inner base appendaged, appendage free, margins generally entire, apex broad. Amphigastria a little broader than the stem, ovate oblong, base auriculate on both sides, margins entire, apex obtuse, acute or truncate. Female shoot (only young ones seen) on a short stalk. Bracts like the leaves but much smaller; bracteoles narrower than the amphigastria.

Plate VII, figures 5-9.

Hab. On rocks.

Distrib. *Mussoorie*; *Chamba*, 4,000 ft.

*Note.*—The plants described above are very near *M. acutifolia* L. et L.

Specimens from *Chamba* show some difference from the description given above. The leaves usually possess several coarse teeth below the apex and the anterior margin of the leaf has a few faint irregular teeth. The female branch is quite sessile and the bracts are narrower and longer.

24. *Madotheca variabilis* Sp. Nov.

Brownish green. Stem about 5 cm. long, pinnate, pinnæ sometimes again bearing pinnules. Leaves slightly imbricate, horizontal, ovate to ovate-oblong, 1.5 mm.  $\times$  1.00 mm., antical basal portion entire, rounded, ampliate, covering and crossing the stem, postical basal portion decurrent along the stem, anterior margin convex, posterior straight, apex usually rounded. Upper cells 18–22  $\mu$ , basal cells up to 45  $\mu \times$  27  $\mu$ ; walls rather thick, trigones not conspicuous in the apical region, distinct, sometimes nodulose in the basal portion. Lobule small, distant, triangular-ligulate to sagittate, 0.55 mm. long and 0.25 mm. broad at the base and 0.11 mm. in the upper part, base auriculate, on the inner side with a large rounded auricle, often with a tooth-like appendage on the outer side also, margins entire, apex obtuse. Amphigastria distant, oblong-ligulate to quadrate, ordinarily up to 0.5 mm. long and 0.35 mm. broad at the base, 0.18 mm. at the apex, base hardly decurrent, slightly auriculate on each side, margin entire, apex usually truncate, occasionally rounded, obtuse, rarely retuse; sometimes on the same branch much larger (about three times as long and three times as broad as the other amphigastria), margin entire, apex entire or toothed. Female shoot with a short leafless stalk. Bracts (only young specimens seen) a little smaller than the leaves, unequal, ovate, entire, or with a few inconspicuous teeth here and there in the upper part; lobule ovate-ligulate. Bracteole large, quadrate, apex broad, faintly toothed.

Plate VIII, figures 1–5.

Hab. On rocks.

Distrib. Mussoorie.

*Note.*—The plant resembles *M. Porella* (Dicks.) Nees closely but differs from that in exhibiting a great variability. The leaf apex is rounded or has one or two teeth. The lobule has an auriculate base. The amphigastria are often very large and then generally toothed at the apex and sometimes even at the base. The trigones may be inconspicuous or well-marked and nodulose.

25. *Madotheca platyphylla* (L.) Dum.

*Jungermannia platyphylla* L., Sp. Pl., p. 1134 p.p. (1753).

*Madotheca platyphylla* Dum., Comm. Bot., p. 111 (1822).

Green, on rocks and bark. Stem up to 10 cm. long, closely and regularly bipinnate, lower pinnæ short, upper long, patent (in specimens from Lahul). Leaves closely imbricate, patent-divergent, slightly convex, oblique, ovate-cordate, up to 2.25 mm.  $\times$  1.55 mm., fixed by a deep base, antical basal portion rounded, covering and slightly crossing the stem, decurrent, wing triangular, acute, margin crisped, directed upwards, postical basal portion crisped, ampliate to auriculate, margin entire, apex incurved, obtuse or rounded. Upper cells 20–32  $\mu$ , basal cells slightly larger, some up to 45  $\mu \times$  32  $\mu$ ; walls and trigones equally thickened. Lobule ovate, up to 1 mm. long and 0.50 mm. broad at the base, inner base longly decurrent on the stem, outer base appendaged, margins entire, sometimes revolute (in young branches), apex obtuse or rounded. Amphigastria lunate, inserted by a deep notch, longly decurrent on both sides, margin entire, apex rounded, revolute. Androecia spicate, elliptic to oblong, bracts 4–6 pairs, closely imbricate. Involucral bracts appressed, smaller than the leaves, margins toothed or entire, apex acute; lobule broadly lanceolate. Bracteoles appressed, broadly ovate, as large as the bracts, margin entire, apex narrowed, recurved, obtuse. Perianth pyriform, mouth truncate; more or less coarsely dentate. Capsule large, globose. Spores golden-yellow, 40  $\mu$ . Elaters closely bispiral, 200  $\mu$ .

Plate VIII, figures 6–10.

Hab. On rocks and bark.

Distrib. Kagan Valley (Inayat, 1896); Liddar Valley (Kashmir), 6-7,000 ft. and 10,000 ft. (Duthie, 1893); Gulmerg (Kashmir), 8-9,000 ft. (Duthie, 1893) (Herb., F.R.I., Dehra Dun); Ravi Valley; Lahul.

26. *Madotheca decurrens* St.

*Madotheca decurrens* St., Sp. Hep., Vol. IV, p. 289 (1910).

Light green, on rocks. Stem about 6 cm. long, bipinnate, pinnæ close. Leaves imbricate, horizontal, oblique, broadly ovate,

2.0 mm.  $\times$  1.5 mm.; base small, antical basal portion covering the stem and crossing far beyond it, decurrent, margins entire, apex rounded, margins and apex recurved. Upper cells 20  $\mu$ , walls slightly thickened, trigones small; basal cells 36–48  $\mu \times$  28–35  $\mu$ , walls slightly thickened, trigones acute. Lobule oblong, 0.75 mm. long and 0.25–0.50 mm. broad, inner base longly decurrent on the stem, external base with a rounded auricle, margin revolute, apex recurved, rounded. Amphigastria suborbicular-quadrata, 0.75 mm.  $\times$  0.75 mm., base longly decurrent on both sides, margins crisped, incurved, apex crisped, recurved, truncate or rounded. Androecia spicate, oblong, bracts about 5 pairs. Rest not seen.

Plate IX, figures 1–4.

Hab. On rocks.

Distrib. *Decota* (Tehri State), 8,000 ft. (Gamble, 1892); Kagan Valley (Inayat, 1896) (Herb., F.R.I., Dehra Dun); Western Himalayas locality not noted; Mussoorie; Bhagirathi Valley, above Bhatwari, 4,900 feet.

*Note*.—The Kagan specimens are more green. The plants are a little larger and so are the leaves (antical lobe). The leaves are not recurved. The lobule is smaller. The lobules and amphigastria are not so strongly overlapping as in the Tehri specimens.

This species resembles *M. platyphylla* very greatly. It can, however, be distinguished by the following characters:—Leaves horizontal, lobe very broadly ovate, the antical basal portion being much larger, lobule broader and oblong, and the amphigastria longer with strongly crisped margins and apex.

## 27. *Madotheca Gambleana* St.

*Madotheca Gambleana* St., Sp. Hep., Vol. IV, p. 289 (1910).

Green, stem 6 cm. or more, rigid, brownish green, densely bi- to tri-pinnate, primary pinnæ 3–5 cm. long. Leaves imbricate, patent-divergent, oblique-ovate, 1.5 mm.  $\times$  1.0 mm., margins undulate, antical basal portion covering and crossing the stem, rounded, decurrent on the stem, postical base much twisted, lower half of the margin curved inwards and very concave *in situ*, apex

rounded or obtuse. Upper cells 18–20  $\mu$ , walls and trigones equally thickened; basal cells 44–48  $\mu \times$  32–36  $\mu$ , trigones rather large. Lobule oblong, about 0.5 mm. long and 0.25 mm. broad, inner base appendaged, appendage long linear, undulate, margins revolute, apex obtuse or rounded. Amphigastria oblong, base unequally longly decurrent on both sides, margin crisped, apex revolute, truncate, notch obtuse or acute. Androecia spicate, oblong, bracts about 6 pairs. Involucral bracts appressed, as large as the leaves and similar, margin entire or toothed, apex obtuse or acute; lobule long, upper part and apex denticulate. Bracteoles appressed, ovate-oblong, upper part of the margin faintly toothed or entire, apex broad. Perianth compressed, suborbicular. Spores brown, punctate-muriculate, with a broad wing, 40  $\mu$ . Elaters concolorous, laxly bispiral, 340  $\mu$ , some smaller (120  $\mu$ ) with close spirals. Some elaters branched.

Plate IX, figures 5–9.

Hab. On bark of trees.

Distrib. Tehri Garhwal, 4,000 ft. (Gamble, 1835) (Herb., F.R.I., Dehra Dun); Kulu Valley, 6,000 ft.; Ravi Valley, 6,000 ft.; Pangi; Kumaon; Bhagirathi Valley, Bhatwari, 4,900 ft.

Note.—Some short elaters, 80–120  $\mu$ , are always fixed to the base and apex of the capsule.

## 28. *Madotheca macroloba* St.

*Madotheca macroloba* St., Sp. Hep., Vol. IV, p. 292 (1910).

Brownish green, dense depresso-caespitose. Stem about 8 cm. long, pinnate and irregularly bipinnate. Leaves imbricate, patent-divergent to horizontal, oblique, broadly ovate to subrotund, 2.25 mm.  $\times$  1.5 mm., attached by a broad base (as broad as the stem), antical basal portion entire, rounded, covering and slightly crossing the stem, postical slightly or not at all decurrent, margins entire, apex rounded, slightly recurved. Upper cells 18–20  $\mu$ , basal cells 40–45  $\mu \times$  25–30  $\mu$ ; walls thin, trigones large. Lobule large, broadly ovate, 1.5 mm. long and 1.25 mm. broad, outer base entire, inner base appendaged, appendage decurrent along the stem,



margins entire, apex rounded or obtuse. Amphigastria orbicular, 0.75 mm. long (including the decurrent portion) and 1.0 mm. broad, inserted by a broad base, longly decurrent on both sides, margins incurved, apex rounded, incurved.

Plate IX, figures 10-13.

Hab. On rocks and trees.

Distrib. Kumaon ; Garhwal ; Pangi ; Kulu Valley ; *Chamba* ; *Barmaur Road* ; *Ahwas*, 6,000 ft.

### 29. *Madotheca gracillima* Mitt.

*Madotheca gracillima* Mitt., Trans. Linn. Soc. II Ser., Vol. III, p. 202 (1891).

Green. Stem about 6 cm. long, irregularly bipinnate. Leaves closely imbricate, horizontal, apex strongly decurved, broad, rounded, ovate-oblong to oblong, up to 1.5 mm.  $\times$  1.0 mm., fixed by a broad base, antical base entire, rounded, covering the stem and crossing it, postical slightly decurrent, margins entire or posterior margin with a tooth near the base. Upper cells 12-18  $\mu$ , median cells 16-20  $\mu$ , basal cells 24-32  $\mu \times$  16-20  $\mu$ ; walls uniformly thick, trigones not distinct. Lobule oblong-ligulate, 0.75 mm. long and 0.25 mm. broad, slightly decurrent on the inner side, more or less toothed, outer base appendaged with one or a few coarse teeth, margins more or less recurved, entire, apex obtuse. Amphigastria quadrate-oblong, up to 0.6 mm.  $\times$  0.5 mm., base decurrent on both sides, margin especially its lower portion generally coarsely denticulate, apex strongly recurved, rounded.

Plate X, figures 1-5.

Hab. On rocks, on soil, or on bark.

Distrib. *Moral* (beyond Simla), 12,500 ft. (Brown, 1888) ; *Mundali* (Jaunsar), 8,000 ft. (Gamble, 1892) ; Kagan Valley, 14,400 ft. (Inayat, 1896) (Herb., F.R.I., Dehra Dun) ; *Dalhousie* ; Pangi ; Kumaon ; *Mussoorie*.

*Note*.—In the specimens from *Dalhousie* the upper cells are rather smaller and some of the basal cells a little longer.

30. *Madotheca obtusifolia* Sp. Nov.

Sterile, green, brown in older parts, among and on mosses. Stem about 4 cm. long, bipinnate. Leaves horizontal, ovate to ovate-oblong, up to 1.75 mm. long and 1.25 mm. broad, base narrow, antical basal portion entire, rounded, covering and often slightly crossing the stem, margins entire, apex rounded, recurved. Upper and median cells  $12-18\ \mu$ , walls slightly thickened, trigones indistinct; basal cells  $24-36\ \mu \times 18-24\ \mu$ , walls thick, trigones distinct. Lobule oblong-ovate, 0.50 mm. long and 0.25 mm. broad, outer base with or without a small appendage, inner base slightly decurrent on the stem, margins entire, apex obtuse or rounded. Amphigastria quadrate to quadrate-oblong, base decurrent on both sides, margin entire, apex rounded; often, however, with one or two teeth on each side just above the base.

Plate X, figures 6-10.

Hab. On rocks.

Distrib. Kashmir; Garhwal, above *Kauria*, 7,000 ft.

*Note*.—The plant differs from *M. gracillima* St. in nearly always having entire lobes, lobules and amphigastria, and is near *M. angusta* St.

The following species of *Madotheca* have been described by Stephani but have not been seen by us.

31. *Madotheca angusta* St.

*Madotheca angusta* St., Sp. Hep., Vol. IV, p. 288 (1910).

Sterile, medium, light green, flaccid. Stem up to 5 cm. long, dark brown, weak, irregularly remotely bipinnate. Leaves contiguous, strongly spreading, broadly ovate, apex decurved, entire, dorsal covering the stem (1.8 mm. long and 1.2 mm. broad). Upper cells  $18\ \mu$ , basal  $27\ \mu \times 18\ \mu$ , trigones small. Lobule oblique, spreading, base plano-appressed, oblong-triangular, 1.2 mm. long, base 0.8 mm. broad, acute or obtuse, entire or external base hastate-spinose. Amphigastria remote, appressed to the stem, narrowly ovate, twice as broad as the stem, entire, decurrent on one side, the decurrent portion shortly crispate-laciniate.

Hab. Himalaya.

*Note*.—Stephani in a note to this species says that this plant has been wrongly identified by Mitten as *M. lævigata* Dum.

Mitten (Jour. Proceed. Linn. Soc., 1860-1861, Vol. V, pp. 108-109) gives the distribution as follows:—

In Himalayæ et Tibetiæ occidentalis reg. temp., Kashmir, alt. 6,000 ped., T.T. (No. 1564); Nubra, alt. 11,000 ped., T.T. (No. 1571); Simla, 7,000, T.T. (No. 1569); Kumaon, *Strachey et Winterbottom*.

### 32. *Madotheca hastata* St.

*Madotheca hastata* St., Sp. Hep., Vol. IV, p. 290 (1910).

Sterile, large, robust but also flaccid, brown turning green towards the apex. Stem up to 8 cm. long, irregularly densely pinnate, pinnae contiguous, long and short, obliquely spreading, sparsely pinnulate. Leaves slightly imbricate, strongly spreading, strongly concave, broadly ovate (2.6 mm. long, base 2.2 mm. broad), entire, margin frequently irregularly incurved, subcrispate, antical basal portion transversely inserted, covering the stem. Upper cells  $27\ \mu \times 18\ \mu$ , trigones large, subnodulose; basal cells  $45\ \mu \times 27\ \mu$ , trigones narrow. Lobule small, ovate, apex obtuse, external margin strongly incurved, internal angle of the base with a long appendage, appendage hardly smaller than the lobule, decurrent on the stem, linear, margin crisped. Amphigastria as broad as the thickness of the stem or less, subquadrate, apex truncate, entire, margins recurved, nude or pauci-dentate, base hastate-spinous, longly decurrent, wing linear, nude or sparsely toothed.

Hab. Himalaya (*Mussoorie*).

### 33. *Madotheca ovalis* G. Ms.

*Madotheca ovalis* G. Ms., St., Sp. Hep., Vol. IV, p. 292 (1910).

*Madotheca platyphylloidea* Dum.; Mitt., Jour. Proc. Linn. Soc., Vol. V, p. 109 (1861).

Dioecious, pale yellow, delicate. Stem thin, deep brown. Leaves imbricate, strongly spreading, apex decurved, broadly ligulate (2.4 mm.  $\times$  1.6 mm.), apex broadly truncate, rotundate, inserted by a small base, antical basal portion strongly ampliate, broadly covering the stem, entire. Upper cells  $18\ \mu$ , median  $27\ \mu$ , basal

36  $\mu \times 27 \mu$ , trigones small. Lobule obliquely spreading, ovate acuminate, acute, external base ampliate, rounded, entire. Amphigastria twice as broad as the stem, ligulate, twice as long as broad, apex broadly rotundate, base unequally decurrent, wings narrow, entire. Bracts intimate, as long as the leaves, ovate-elliptic, apex acuminate, acute, base strongly narrowed, inserted by a narrow base, antical margin strongly dentate, the rest entire; lobule about half the size of the bract, obovate, coarsely dentate, mostly free. Bracteoles intimate, obovate, above the middle remotely dentate.

Hab. Himalaya et Tibetia occidentali temperata, Simla, 7-8,000 ped., T.T. (Nos. 1562, 1568); Nubra, alt. 11,000 ped., T.T. (No. 1572).

#### 34. *Madotheca trigonifolia* St.

*Madotheca trigonifolia* St., Sp. Hep., Vol. IV, p. 293 (1910).

Dioecious, medium, brown, flaccid, on rocks, dense depresso-cæspitose. Stem up to 5 cm. long, thin, brown, weak, regularly remotely pinnate, pinnae 5 mm. long, obliquely spreading, simple, rarely pinnulate, pinnules small. Leaves strongly imbricate, highly decurved, strongly spreading, broadly rotundate (3.6 mm. long and broad), apex broadly triangular, obtuse, inserted by a narrow base, above the base on both sides pauci-dentate, teeth remote, small, strong. Upper cells 27  $\mu$ , basal cells 36  $\mu \times 27 \mu$ , trigones large, acuminate. Lobule narrow, upper half triangulate repand, apex obtuse, base decurrent on both sides, wings broadly linear, unequal, external wing entire, internal wing regularly dentate. Amphigastria suborbicular, inserted by a sinus, longly decurrent on one side, wing narrow, lanceolate, acuminate, as long as the amphigastrium, margin repando-dentate or ciliate. Involucral bracts as long as the leaves, oblong, broadly acuminate, acute, dorsal base strongly obtusely dentate; lobule small, ovate-oblong, free for a long distance, entire, apex subacut. Bracteoles intimate, suborbicular, densely and regularly denticulate. Perianth cupulate, mouth broadly truncate, strongly lobed, lobes triangular, acuminate, entire.

Hab. Himalaya (Kashmir, Liddar Valley).

35. *Madotheca virens* St.

*Madotheca virens* St., Sp. Hep., Vol. IV, p. 294 (1910).

Sterile, small, green, flaccid, dense-cæspitose. Stem up to 5 cm. long, deep green, weak, densely pinnate, pinnæ up to 15 mm. long, lower pauci-bipinnate. Leaves imbricate, strongly decurved, ovate (2·8 mm. long, middle 2·4 mm. broad), inserted by a narrow base, antical base armed with large teeth, the rest entire. Upper cells 18  $\mu$ , median 27  $\mu$ , basal 27  $\mu \times 18 \mu$ , trigones absent. Lobule distinctly coalesced with the leaf, carina arcuate, canaliculate concave, ovate, subacute, margin repand, internal basal angle longly appendiculate, appendage slightly decurrent, long attenuate, denticulate. Amphigastria broadly triangular, obtuse or truncate, decurrent on both sides, wing unequal, in some short entire, in others shortly decurrent sublobate.

Hab. Himalaya (Kagan).

36. *Madotheca densiramea* St.

*Madotheca densiramea* St., Sp. Hep., Vol. IV, p. 298 (1910).

Diœcious, small, yellowish green, flaccid. Stem up to 5 cm. long, regularly pinnate, pinnæ approximate, long, some pinnulate. Leaves imbricate, delicate, rather spreading, convex, some crisped, broadly ovate (2·4 mm. long, middle 2 mm. broad), asymmetrical, apex obtuse, inserted by a small base, and on both sides cordate-rotundate, antical margin strongly arcuate. Upper cells 27  $\mu$ , median and basal cells 30  $\mu \times 27 \mu$ , trigones everywhere large, acute. Lobule very concave, ovate-oblong, on both sides longly and narrowly decurrent, apex shortly acuminate, obtuse, entire. Amphigastria rectangular [10·8 mm. broad (1·08 ?) and 1·2 mm. long], apex truncate-rounded, base briefly decurrent on both sides, entire. Andrœcia few, shortly spicate, bracts four pairs.

Hab. Himalaya (*Chamba*).

37. *Madotheca densifolia* St.

*Madotheca densifolia* St., Soc. nat. Cherbourg, Vol. XXIX, p. 219 ;  
Sp. Hep., Vol. IV, p. 301 (1910).

Sterile, large, very robust, light or deep green, mixed with mosses, on bark. Stem up to 8 cm. long, thick and hard, irregularly pinnate. Leaves imbricate, strongly spreading, plano-distichous, ovate-oblong (3.2 mm. long, base 2 mm. broad) asymmetrical, postical margin entire, antical covering the stem, arcuate, apex narrow acute or acuminate, occasionally oblique truncate-tridentate. Upper cells  $18\ \mu$ , trigones absent, median  $27\ \mu \times 18\ \mu$ , trigones small, basal scarcely larger, trigones large. Lobule large, ovate-oblong or ligulate, apex rounded, base on both sides appendiculate, external appendage rounded, entire, internal covering the stem, long ligulate, apex plurilobate, crisped. Amphigastria ovate-triangular, apex obtuse, base on both sides narrowly decurrent, wing inciso-lobate, margin crisped.

Hab. Himalaya (Kumaon).

The following species of *Madotheca* has been described by Gola but we have not seen this.

### 38. *Madotheca Borellii* Gola.

*Madotheca Borellii* Gola, Atti Della R. Accad. Delle Sci. Di Torino, Vol. XLIX (1914).

Diœcious, medium, lower dark green, upper light green or olive green, flaccid, cæspitose. Stem up to 5 cm. long, weak, irregularly bipinnate, the branches occasionally flagelliferous. Leaves strongly contiguous, imbricate, obliquely spreading, subsymmetrical (2 mm. long and in the middle 2 mm. broad), strongly decurved, broadly ovate trigonous, apex rotundate-obtuse, entire, inserted by a narrow subcordate base, antical base shortly appendaged, appendage ovate, acuminate, margins everywhere entire or the antical margin at the base angulate or 1-2-denticulate. Upper cells  $23\ \mu$ , median  $30\ \mu$ , basal  $25\ \mu \times 18\ \mu$ , walls thick, trigones minute. Lobule small, ligulate, canaliculate, entire, slightly appendaged. Amphigastria twice as broad as the stem, semi-circular, apex strongly decurved, broadly rotundate, entire, on both sides longly and broadly decurrent. Bracts closely appressed to the perianth, as large as the leaves, much smaller than the perianth, entire. Bracteole broadly ovate, entire. Perianth compresso-campanulate,

mouth narrow, truncato-lobate, lobes ciliolate. Male plants delicate. Andrœcia small, subglobose, bracts about three pairs.

Hab. Kashmir, Sind Valley.

*Note.*—Gola says in a note that the plant is allied to *M. decurrens* St. from which it differs in the position of the leaves which are oblique and not patent, the dimensions of the cells of the leaf, and the form of the lobule and its small appendages. It differs from *M. ovalis* Gott. in the form of the leaf, the lobule, and the bracts being not toothed. Similarly from *M. densiramea* St. it is quite distinct specially in the position of the leaves.

### FAMILY III. PLEUROZIACEÆ.

Plants usually large, with erect stems from a rhizomatous base, branches lateral. Leaves incubous, nearly always two-lobed, antical lobe large, postical lobe smaller, saccate, its narrow mouth often closed by a complicated valve apparatus. Amphigastria absent. Antheridia and archegonia on short lateral branches. Andrœcia small, bracts in 6–12 pairs, imbricate, monandrous. Perianth elongate and narrow, generally 4–10-plicate, mouth contracted. Capsule oval, 4-valved to the base. Elaters deciduous, bispiral. Only genus *Pleurozia*. (Not represented in the Western Himalayas.)

#### *Pleurozia* Dum.

*Pleurozia* Dum., Rec. d'obs., p. 15 (1835).

Characters same as those of the family. Not represented by any species in this area.

### FAMILY IV. RADULACEÆ.

Plants generally of medium size, closely attached to the substratum. Stems laxly pinnate or bipinnate. Leaves incubous,

complicate-bilobed, the postical lobe (lobule) smaller with its free margin generally appressed to the underside of the antical lobe; rhizoids arising from the under surface of the lobule. Amphigastria absent. Androecia terminal, bracts with 1 or 2, rarely 3, antheridia. Archegonial cluster generally terminal on the main stem, frequently with 1-2 sub-involucral innovations. Perianth usually strongly dorsi-ventrally compressed, rarely subterete, very rarely plicate, the mouth wide, truncate, bilabiate. Capsule shortly and stoutly pedicelled, generally oval-cylindrical, 4-valved to the base, the wall of two layers of cells. Only genus *Radula*.

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#### IV. RADULA Dum.

*Radula* Dum., p.p., Comm. Bot., p. 112 (1822); Rec. d'obs., p. 14 (1835).

*Martinellius* S. F. Gray, p.p., Nat. Arr. Brit., Pl. I, p. 691 (1821).

*Stephanina* O. Kuntze, Rev. Gen. Pl., p. 839 (1891); Schiffn. in Engl. und Prantl, Nat. Pflanz. 13, p. 113 (1895).

Characters same as those of the family.

*Note*.—There is no difficulty in recognising this genus, because of its peculiar yellowish green colour, quadrate lobule, the absence of amphigastria, and the rhizoids arising from a mammillate protuberance of the lobule.

#### 39. *Radula complanata* (L.) Dum.

*Jungermannia complanata* L., Sp. Pl., p. 1133 (1753).

*Radula complanata* Dum., Comm. Bot., p. 112 (1822).

In thin, pale yellowish green or whitish green patches, closely attached on rocks or bark of trees, usually mixed with Mosses and other Liverworts. Stem up to 2 cm. long, laxly and irregularly pinnate, or even bipinnate. Leaves imbricate, inserted by a broad base, strongly spreading, quadrate to suborbicular, up to 0.75 mm.  $\times$  0.5 mm., antical basal portion rounded, not or very slightly crossing over the stem, margins entire, apex rounded. Cells mostly alike, 18-24  $\mu$ , walls and angles thin. Lobule half as long as the



lobe, closely appressed to the lobe and the stem, quadrate, not crossing the stem, the angle acute or obtuse. Bracts like the leaves. Perianth tubular, dorsi-ventrally compressed, mouth bilabiate, entire. Gemmæ marginal, multicellular.

Plate XI, figures 1-4.

Hab. Rocks and trees.

Distrib. Widely distributed. *Patni pass*, Jammu; *Alwas-Silrundi Road*, *Silrundi*, 8-10,000 ft.; *Pangi Road*; *Khajiar*; *Dalhousie* (very common); *Simla*; *Garhwal*, *Mussoorie*; *Kumaon*; *Sikkim*; *Kotagiri*, 7,000 ft. (Sedgwick, 1916).

The following species of *Radula* have been described by Stephani but have not been seen by us.

#### 40. *Radula grandifolia* St.

*Radula grandifolia* St., Sp. Hep., Vol. IV, p. 184 (1910).<sup>1</sup>

Sterile, large, pale green, rigid, on bark, mixed with mosses. Stem up to 3 cm. long, shortly remotely pinnate, pinnæ with small leaves. Leaves large, imbricate, strongly spreading, concave, apex strongly decurved, broadly ovate, 2.4 mm. long, middle 1.8 mm. broad, apex rounded, base to about the middle accrete, upper half free, ampliate, covering the stem. Marginal cells 13  $\mu$ , upper cells 18  $\mu$ , basal 27  $\mu$ , trigones absent. Lobule large, subrectangular (1 mm. long and 0.8 mm. broad), apex strongly truncate, angle acute, base long accrete (about  $\frac{3}{4}$ ), upper quarter free, shortly ampliate, slightly covering the stem, carina somewhat spreading, substrict, the angle excurrent from the leaf margin.

Hab. Himalaya (*Simla*).

#### 41. *Radula Douleana* St.

*Radula Douleana* St., Sp. Hep., Vol. IV, p. 184 (1910).

Sterile, medium, flaccid, light green, on bark. Stem about 3 cm. long, regularly densely pinnate, pinnæ small. Leaves imbricate, strongly spreading, concave, apex decurved, broadly elliptic, dorsal and apical part equally broad, truncate-rotundate and up to  $\frac{2}{3}$  accrete with the stem, upper  $\frac{1}{3}$  free, covering the stem,

1.46 mm. long and 1.06 mm. broad. Upper cells  $15\ \mu$ , median cells  $18\ \mu$ , basal  $27\ \mu \times 18\ \mu$ , trigones usually small. Lobule large, subquadrate, 0.65 mm. long and broad, apex rather strongly truncate, angle subacute, base up to  $\frac{2}{3}$  accrete, upper  $\frac{1}{3}$  ampliate, covering the stem, carina strongly sinuate, longly decurrent, excurrent from the leaf margin.

Hab. Himalaya, Simla, 7,000 ft.

Gola (Atti Della R. Accad. Delle Sci. Di Torino, Vol. XLIX, 1914), has reported *Radula Lindenbergiana* G. from Kashmir, but we have not seen any specimens of this species. Stephani has described the same plant as *Radula Lindbergii* G. in Species Hepaticarum but he does not mention any part of India under its distribution. The following description is after Stephani.

#### 42. *Radula Lindbergii* G.

*Radula Lindbergii* G., in Jack Flora, 1881.

Dioecious, medium, green or yellowish green, on bark or rocks. Stem up to 3 cm. long, primary branches few, densely and shortly pinnate. Leaves more or less erecto-patent, plano-distichous or slightly concave, apex decurved, broadly elliptic, 1.46 mm. long and middle 0.93 mm. broad, apex rounded, lower half of the base united with the stem, upper half free, ampliate, crossing the stem. Upper cells  $18\ \mu$ , basal  $27\ \mu \times 18\ \mu$ , walls thin. Lobule subrectangular, 0.65 mm. long and middle 0.53 mm. broad, apex strongly truncate, angle obtuse and prominent, lower half of the base united with the stem, upper half free, slightly ampliate, slightly crossing the stem. Carina almost straight, obliquely spreading. Perianth unilaterally innovating, oblong, 3 mm. long, mouth entire. Bracts as long as the leaves, falcate, spatulate; lobule similar but smaller. Androecia numerous on slender plants, terminal on branches, bracts about 10 pairs, highly saccate, upper conduplicate, bilobed, lobes rounded, postical smaller.

Hab. Kashmir.

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## FAMILY V. SCAPANACEÆ.

Plants usually large. Branches usually lateral. Leaves alternate, complicate-bilobed, the antical lobe smaller than the postical lobe (lobule). Amphigastria usually absent. Androecia terminal, spicate, bracts di-poly-androus. Perianth free, dorsi-ventrally compressed, or subinflated and 4-pluriplicate. Capsule 4-valved to the base.

*Key to the genera.*

Mouth of the perianth contracted	..	<i>Diplophyllum</i>
Mouth not contracted, wide	..	<i>Scapania</i>

\*       \*       \*       \*       \*

## V. DIPLOPHYLLUM Dum.

*Diplophyllum* Dum., Rec. d'obs., p. 15 (1835).

Plants small or medium. Stems arising from a creeping rhizome, branches few, lateral. Leaves semi-amplexicaul, distichous, more or less deeply complicate-bilobed, keeled, antical lobe smaller than the postical lobe. Amphigastria absent. Androecia terminal or intercalary, base of the bract saccate, inflated, bracts moni-androus, rarely bi- or tri-androus. Involucral bracts usually in three pairs, similar to the leaves, large. Perianth ovate, inflated, pluriplicate, mouth contracted, armed. Capsule longly pedicellate, 4-valved, wall of many layers of cells, cells of the innermost layer with semi-annular bands. Gemmæ often present on tips of the leaves.

43. *Diplophyllum orientale* St.

*Diplophyllum orientale* St., Sp. Hep., Vol. IV, p. 115 (1910).

*Scapania orientalis* St., in Muller, Mongr. Scapaniæ. Nova Acta, Vol. 83, p. 298 (1901).

Diœcious, small, dense depresso-cæspitose. Stem up to 3 cm. long, brown, simple or sparsely branched. Rhizoids numerous, from the ventral side of the stem. Leaves small below gradually becoming larger, imbricate, patent-divergent; antical lobe ovate to

reniform, broader than long, 1.25 mm.  $\times$  1.0 mm., inserted by a broad base, free margin longly decurrent, crossing the stem, basal portion of the margin entire, rest usually regularly armed with 1-2-celled teeth or with a few teeth or entire, apex acute, occasionally entire, rounded; carina (commisure) not winged, arched; postical lobe quadrate to orbicular-ovate, up to 1.75 mm.  $\times$  1.5 mm., inserted by a deep narrow notch, free margin decurrent, margins remotely and often irregularly toothed, rarely entire, teeth sharp, apex usually with a short tooth. Upper cells 16–20  $\mu$ , basal cells 44–56  $\mu \times$  20–28  $\mu$ ; walls thin, trigones thick. Involucral bracts similar to the leaves. Perianth obovate-oblong, inflated, mouth contracted plicate, ciliate.

Plate XI, figures 5–9.

Hab. On soil.

Distrib. Above *Jalla* (Ganges Valley), 11,000–12,000 ft., (Duthie, 1881), Herb., F.R.I., Dehra Dun.

## VI. SCAPANIA Dum.

*Scapania* Dum., Rec. d'obs., p. 14 (1835).

Stems arising from a creeping rhizomatous portion, branches few, lateral. Leaves transversely inserted, distichous, complicate-bilobed, nearly always keeled, the antical lobe smaller than the postical lobe. Amphigastria absent. Androecia spicate, rarely hypogynous, bracts nearly equally bilobed and generally with entire margins, 2-3-androus. Involucral bracts similar to the stem leaves. Perianth terminal, longly exserted, inflated below, dorsi-ventrally compressed above, decurved, mouth wide, truncate, usually dentate. Capsule longly exserted, oval to globose, 4-valved, wall of two layers of cells, cells of the inner layer with semi-annular thickening bands.

*Key to the species.*

Cuticle smooth or granulose	.. <i>S. purpurea</i>
Cuticle verrucose ..	.. <i>S. verrucosa</i>

44. *Scapania verrucosa* Heeg.

*Scapania verrucosa* Heeg., Revue Bryol., 1893, p. 81.

Sterile, small, brownish green to dark brown, laxly caespitose. Stem up to 3 cm. long, deep brown below, light brown above, simple or sparsely branched. Rhizoids fairly numerous, in some plants none. Leaves more or less imbricate, patent, decurved, amplexicaul, antical lobe rhomboid-oblong, up to 1.3 mm.  $\times$  1.0 mm., base broad, oblique, non-decurrent, margins with a few or many small unicellular teeth, apex rounded, obtuse or acute; commissure narrow, arched, not winged; postical lobe obliquely elliptic-oblong, up to 2 mm.  $\times$  1.25 mm., base narrow, free margin longly decurrent on the stem, margins with numerous small unicellular teeth, apex acute, sometimes rounded. Cells (of the lobule): upper 12–16  $\mu$ , walls thick, trigones not conspicuous; median 18  $\mu$ , walls thick, trigones well marked; basal up to 36  $\mu$   $\times$  18  $\mu$ , walls thick, trigones nodulose; cuticle verrucose, the surface appearing to be covered with numerous circles in surface view.

Plate XII, figures 1–7.

Hab. On moist rocks.

Distrib. *Dalhousie*; above *Alwas*, 8,000 ft.

Note.—The size of the leaves is very variable, the figures given in the description apply to the largest leaves.

45. *Scapania purpurea* Sp. Nov.

Dicecious, small, erect, lower half brown or reddish brown, upper half more or less purplish. Stem about 1.5–3 cm. long, simple or sparsely branched. Rhizoids scarce, confined to the base. Leaves increasing in size towards the apex, imbricate, patent, amplexicaul, antical lobe quadrate-oblong to oblong-reniform, up to 1 mm.  $\times$  0.70 mm., transversely inserted by a narrow base, widely crossing the stem, free margin longly decurrent, margins entire or with small unicellular teeth, apex rounded, obtuse, or acute; commissure long, arched, not winged; postical lobe up to 1.5 mm.  $\times$  1 mm., subrectangular, base narrow, longly decurrent on the stem, margins wavy with numerous short teeth, apex rounded, obtuse or acute. Cells (of the lobule): upper

10-15  $\mu$ , walls thickened, trigones somewhat prominent; median 15-20  $\mu$ , walls thin, trigones rather thick; basal 36-48  $\mu \times 12$ -20  $\mu$ , walls and trigones generally thickened, often the walls thin and the trigones absent; cuticle smooth. Involucral bracts like the leaves but larger. Perianth very broad, subquadrate, highly compressed, mouth wide, margins toothed.

Plate XII, figures 8-13.

Hab. On rocks under snow.

Distrib. Above *Silrundi*, foot of the *Sach Pass*, 12,000 ft.

\*The following species of the genus has been described by Stephani but has not been seen by us.

#### 46. *Scapania parva* St.

*Scapania parva* St., Mem. Soc. Nat. Cherbourg., Vol. 29, p. 226;

Sp. Hep., Vol. IV, p. 142 (1910).

Dioecious, small or medium, pale yellowish green or brown, commonly growing mixed with mosses on bark. Stem up to 5 cm. long, thin, brown, rigid, almost simple. Lobe remote, oblique, spreading, more or less decurved, oblong-elliptic, 1.86 mm. long and in the middle 0.93 mm. broad, apex broadly triangular, acute, base shortly decurrent, margin with small unicellular teeth; commissure short, 0.4 mm. long, narrow; lobule subrhomboidal, 1.06 mm. long and 0.8 mm. broad, base longly decurrent, ampliate, crossing well beyond the margin of the lobe, rest similarly toothed, apex truncate, angle acute. Upper cells 13  $\mu$ , median 18  $\mu$ , trigones absent; basal 36  $\mu \times 15 \mu$ , trigones large, attenuated; cuticle coarsely verrucose. Perianth ovate, mouth repando-lobate, denticulate.

Hab. Kashmir.

### FAMILY VI. Ptilidiaceæ.

Plants of medium size, branched, branches lateral or postical. Leaves incubous or transverse; seldom succubous, bi-multi-fid, frequently ciliate or ending in hair-like points. Amphigastria always present and nearly resembling the leaves in shape and

size. Androecia terminal, spicate, bracts 1-3-androus. Archegonia terminal on main stem or lateral branches but never on postical branches, bracts many. Perianth absent or when present 3-10-plicate, contracted or truncate at the mouth, free or adnate to the innermost bracts. Capsule usually shortly pedicellate, ovate with straight valves, or cylindrical with twisted valves.

*Key to the genera.*

- Leaves and amphigastria deeply bilobed, lobes  
broad .. .. . *Anthelia*  
Leaves and amphigastria divided almost to the  
base into 3-5 uniseriate segments .. *Blepharostoma*  
\*        \*        \*        \*

VII. *ANTHELIA* Dum.

*Anthelia* Dum., Rec. d'obs., p. 18 (1835).

Plants small, dense depresso-caespitose. Stem firm, irregularly pinnate. Leaves incubous, more or less imbricate, carinate-concave, subtransversely inserted, bilobed, lobes equal. Amphigastria like the leaves but slightly smaller. Androecia spicate, bracts mon-androus. Female inflorescence terminal. Bracts adnate to the base of the perianth. Perianth pluriplicate, mouth narrow, lobed. Capsule large, shortly pedicellate, 4-valved, wall of two layers of cells. Spores small, rough. Elaters short, bispiral.

47. *Anthelia julacea* (L.) Dum.

*Jungermannia julacea* L., Sp. Pl., p. 1135 (1753); Lightf. Fl. Scot., p. 785.

*Anthelia julacea* Dum., Rec. d'obs., p. 18 (1835). — —

Dioecious, small, in small thick patches, green when fresh and dark brown in the dried condition. Stem up to 1 cm. long, irregularly branched. Rhizoids hyaline, from the under side of the stem throughout its greater part. Leaves usually closely imbricate and appressed, incurved, almost transversely inserted, ovate, up to 0.4 mm. long,  $\frac{2}{3}$  subequally bilobed, sinus narrow, acute, lobes spreading, ovate-lanceolate, entire or faintly and

irregularly or more or less strongly toothed, apex acute. Cells squarish, 18–29  $\mu$ , those in the middle of the lobes oblong, trigones not distinct. Amphigastria resembling the leaves, equal to or slightly smaller than the leaves. Involucral bracts and bracteoles much larger than the leaves and amphigastria otherwise similar, margins entire or faintly denticulate. Perianth oblong-ovate, very slightly or rarely fairly exserted beyond the bracts, pluriplicate, mouth narrowed,  $\frac{1}{2}$ – $\frac{2}{3}$ -lobed, lobes unequal, mostly ovate, entire, acute, some with secondary lobes.

Plate XIII, figures 1–2.

Hab. On rocks.

Distrib. Zaskar, 12,000 ft. ; Kulu Valley, *Rotang-Koti* Road, 11,000 ft.

*Note.*—Specimens from the Kulu Valley show some synthetic characters. The leaves are described as *crenate-dentate* in *A. Julacea* and less *dentate* or *entire* in *A. Juratzkana* but in these specimens entire as well as distinctly toothed leaves occur. Usually the perianth is also intermediate between the two but is more like the latter in not being exserted in many specimens. In a few, however, it is fairly exserted. Unless the present specimens are different from the above two species, the two species are probably not distinct.

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### VIII. BLEPHAROSTOMA Dum.

*Blepharostoma* Dum., Rec. d'obs., p. 18 (1835).

Plants small, delicate, frequently mixed with mosses and other liverworts. Stem thin, delicate, sparsely branched. Leaves succubous, more or less remote, almost transversely inserted, divided almost to the base into 2–5 fine segments composed of a single layer of cells throughout. Amphigastria resembling the leaves but slightly smaller. Androecia spicate, terminal on branches, bracts large, complicate-concave, with the segments often furcate, usually mon-androus. Involucral bracts similar to the leaves, larger, appressed to the perianth, laciniolate-furcate or spinous. Perianth oblong to cylindrical, trigonous with the third angle



postical, mouth contracted, ciliate. Capsule oval, 4-valved, wall of two layers of cells, the inner with semi-annular thickenings. Spores narrow, rough. Elaters bispiral.

48. *Blepharostoma trichophyllum* (L.) Dum.

*Jungermannia trichophylla* L., Sp. Pl., p. 1135 (1753).

*Blepharostoma trichophyllum* Dum., Rec. d'obs., p. 18 (1835).

Dioecious. In small compact patches or scattered among mosses and other liverworts, green when fresh, dark brown when dry. Stem up to 1 cm. long, ascending or procumbent, sparsely branched. Rhizoids long, hyaline. Leaves small and distant on the lower part of the stem, becoming larger and more imbricate higher up on the stem, divided almost to the base into 3-5 setaceous segments (some segments with small secondary segments near the base) composed of a number of cells arranged in one row. Cells near the base  $28-36 \mu \times 18-25 \mu$ , gradually becoming narrower towards the apex, terminal cells generally small, narrow, with an obtuse apex; walls thickened. Amphigastria similar, often slightly smaller. Involucral bracts larger than the leaves, coalesced with the bracteoles, divided nearly to the base into several branched segments which are 1-3 cells broad at the base, otherwise of one row of cells. Perianth longly exserted, cylindrical-clavate, trigonous, mouth contracted, slightly lobed, lobes ciliate.

Plate XIII, figures 3-4.

Hab. On rocks, soil or wood.

Distrib. *Koksir*, 10,000 ft.; *Sitrundi*, 10,000 ft.; *Gurdhar Pass*, 14-15,000 ft.; Kumaon; above *Jalla* (Ganges Valley), 11,000 ft. (Duthie, 1881) (Herb., F.R.I., Dehra Dun).

*Note.*—In the specimens from *Koksir* the leaves are directed forward, closely packed and thus form terminal buds.

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## FAMILY VII. CEPHALOZIACEÆ.

(Trigonanthea Spr.).

Plants large or small. Stem prostrate or procumbent, branching generally pinnate, postical flagellæ often present. Leaves alternate, rarely opposite, usually incubous, usually lobed or toothed, rarely entire. Amphigastria usually present. Male bracts mon-androus, rarely di-androus. Bracts of the female inflorescence tristichous, in a few distichous. Perianth usually free, somewhat elongated and narrow, trigonous, the third angle postical, rarely (by intercalation of secondary angles) 4-6-gonous. Calyptra free, narrow. Capsule oblong or cylindrical, wall of two layers of cells, in a few genera of four or five layers of cells, valves straight.

## Key to the genera.

- |   |   |  |                     |
|---|---|--|---------------------|
| 1 | { | Plants thin, pellucid, amphigastria absent or small .. .. .      | <i>Cephalozia</i>   |
|   |   | Plants robust, not thin, amphigastria quite large .. .. .        | 2                   |
| 2 | { | Leaves and amphigastria alike, 3-5-lobed ..                      | <i>Lepidozia</i>    |
|   |   | Amphigastria different from the leaves and smaller .. .. .       | 3                   |
| 3 | { | Leaf apex rounded, postical flagellæ absent ..                   | <i>Calypogeia</i>   |
|   |   | Leaf apex usually tri-dentate, postical flagellæ present .. .. . | <i>Mastigobryum</i> |

\* \* \* \* \*

## IX. LEPIDOZIA Dum.

*Lepidozia* Dum., Rec. d'obs., p. 19 (1835); Nees in G.L. et N., Syn. Hep., p. 200 (1844).

Plants rather large, rarely small, pale or yellowish green to dark green, caespitose, seldom erect. Stems pinnate or bipinnate, the branches lateral, sometimes flagelliferous and-rooting at the ends, frequently also with postical flagelliferous small leaved branches. Leaves incubous, generally remote, small, convex,

oblique, usually decurved, palmate or quadrifid, more rarely 2-3 or 5-6-fid, the segments acute and more or less subulate. Amphigastria resembling the leaves, but generally slightly smaller. Androecia on short postical branches, seldom terminal on lateral branches, shortly spicate. Female inflorescence on short ventral branches. Bracts appressed, strongly concave, apex armed. Perianth ovate-subulate or fusiform, obtusely trigonous above with the mouth entire, denticulate or ciliate-laciniate. Capsule oblong-elliptic, 4-valved to the base, wall of two layers of cells, inner layer with semi-annular bands. Spores small, rough. Elaters bispiral.

Gola (Atti Della R. Accad. delle Sci. di Torino, Vol. XLIX, 1914) has reported *Lepidozia reptans* (L.) Dum. from Kashmir. It has also been reported by Mitten from Sikkim and by Stephani from Himalaya. We have, however, not seen any species of *Lepidozia* in our collections from the W. Himalayas. The description of this species is given after Stephani.

#### 49. *Lepidozia reptans* (L.) Dum.

*Jungermannia reptans* L., Sp. Pl., p. 1133 (1753).

*Lepidozia reptans* (L.) Dum., Rec. d'obs., p. 19 (1835).

Monœcious, medium, strong, rigid, dense pulvinate, in extended patches. Stem up to 3 cm. long, strong, base flagelliferous, slightly branched, branches dense pinnate, pinnæ slightly spreading, small, frequently attenuated and branched. Leaves contiguous, oblique, spreading, decurved, 0.68 mm. long and broad, asymmetrical, 4-lobed, lobes triangulate-lanceolate, extended or slightly divergent, base 4-5 cells broad, basal disc oblique truncate, antical 0.53 mm., postical 0.27 mm. high, antical margin gently arcuate, postical straight. Cells 27  $\mu$ , in the disc slightly larger, basal few large, 45  $\mu$ ; cuticle smooth; trigones large. Amphigastria large, subcontiguous, spreading, normally broader than long, up to the middle 4-lobed, lobes triangulate, base 4 cells broad, apex obtuse, basal disc obtuse, narrow. Perianth large, base thick, upper part thin, apex shortly inciso-lobate, lobes truncate, spinulose. Bracts appressed, broadly elliptic, apex 4-toothed, concave, antical base slightly coalesced, postical more or less highly

connate with the bracteole to about the middle. Capsule elliptic, cells of the inner layer with semi-annular bands, external of large quadrate thin cells. Spores  $13\ \mu$ , rough. Elaters  $300\ \mu$ , bispiral, spirals loose. Androecia terminal on lateral branches, bracts overlapping, homomalous, concave, bilobed, mon-androus; bracteoles smaller than the bracts.

Hab. On soil.

Distrib. Himalaya, Kashmir, Sikkim.

\* \* \* \* \*

## X. MASTIGOBRYUM Nees.

*Mastigobryum* Nees, G. L. et N., Syn. Hep., p. 214 (1844).

*Bazzania* (*Bazzanius*) S. F. Gray, Nat. Arr. Brit., Pl. I, p. 704 (1821).

Diœcious, mostly robust, cæspitosé, generally olive green, sometimes yellowish or reddish. Stem rigid, forked, with small-leaved ventral flagellæ arising from the angles of the amphigastria. Leaves incubous, alternate or opposite, dorsally convex, more or less decurved, apex generally tridentate to trilobed, in a few cases entire or bidentate. Cells very unequal. Amphigastria large, in a few species small, free or fused with the leaves, spreading or recurved, apex often dentate, truncate or bilobed. Sexual branches postical, from the axils of the amphigastria. Androecia on short amentiform or capitate branches, bracts 4 to 5 pairs, imbricate, complicate-concave, antheridia in pairs, long-stalked. Involucral bracts and bracteoles subequal to the leaves and amphigastria, in a few pairs, complicate-concave, recurved above, more or less long armed. Perianth fusiform, base many layered, fleshy, apical portion deeply triplicate, odd fold postical, mouth narrow, many-lobed, lobes ciliate or hairy. Capsule longly pedicellate, dehiscing to the base by four valves, wall many-layered, inner layer with semi-annular bands. Spores small. Elaters bispiral.

### 50. *Mastigobryum triangulare* (Schleicher) St.

*Mastigobryum triangulare* (Schleicher) St., Sp. Hep., Vol. III, p. 475 (1908).

*Jungermannia triangularis* Schleicher, Crypt. exsicc, 1803; Cent. II, No. 61.

*Bazzania tricrenata* Pears., Hep. Brit. Isles, p. 132, Pl. 49 (1900).

Sterile, reddish brown or purplish, medium, cæspitose, mixed with other liverworts. Stem up to 3 cm. long, ventral flagellæ long and slender, with numerous minute leaves and many rhizoids. Rhizoids long, in tufts, from the under side of the amphigastria near the base. Leaves almost horizontal, convex above, ovate, up to 1 mm. long and 0.75 mm. broad, obliquely inserted by a broad base, antical basal portion ampliate, rounded, covering and crossing the stem, margin entire, apex decurved, with two or three coarse teeth, acute or rounded. Upper cells 16–20  $\mu$ , basal cells 24–30  $\mu$ ; walls and trigones uniformly thickened. Amphigastria distant, large, quadrate-orbicular, 0.25 mm. broad, entire, slightly notched or bilobed, notch acute, extending to about the middle, lobes again crenate-lobulate, sometimes the whole amphigastrium uniformly lobulate.

Plate XIII, figures 5–9.

Hab. On rocks.

Distrib. Above *Jalla* (Ganges Valley), 11,000 ft. (Duthie, 1881) (Herb., F.R.I., Dehra Dun).

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## XI. CALYPOGEIA Raddi.

*Calypogeia* Raddi, Mem. Soc. Ital. d. Sci. in Modena 18, p. 42 (1820).

Plants small or medium, closely appressed to the bark or rarely terrestrial, normally dense depresso-cæspitose, frequently broadly extended, pale or sometimes reddish brown. Stem thick, prostrate or procumbent, simple or with a few branches from the axils of the amphigastria. Rhizoids fasciculæte, usually numerous, long, from the bases of the amphigastria. Leaves incubous, alternate, contiguous or imbricate, plane or convex, oblique or patent-divergent, obtuse, acute or shortly bidentate. Amphigastria large, roundish or reniform, frequently inserted by a deeply sinuous base, apex entire or bilobed. Antheridia and archegonia on very short branches from the axils of the amphigastria. Androecia

spicate, bracts in 3-5 pairs, much smaller than the leaves, ventricose, bilobed and with 2 or more teeth at the apices, mono- or diandrous. Involucral bracts in 2 to 3 pairs, much smaller than the leaves, subrotund, oval or lanceolate, entire or 2-4-fid. Perianth absent. Perigynium (marsupium) with rhizoids, fleshy, pendulous, cylindrical, bearing persistent scale-like bracts at the top and with a layer of papilliform cells on the inner surface. Capsule longly pedicellate, cylindrical, 4-valved, the valves erect and spirally twisted, the wall of two layers of cells, the inner layer with semi-annular bands. Spores small, smooth. Elaters bispiral.

#### 51. *Calypogeia renistipula* St.

*Calypogeia renistipula* St., Sp. Hep., Vol. III, p. 394 (1908).

Sterile, medium, light green or reddish brown. Stem prostrate, about 2 cm. long, simple or sparsely branched. Rhizoids long, hyaline, few, arising from the bases of the amphigastria. Leaves more or less imbricate, patent, convex above, decurved, ovate, up to 0.75 mm.  $\times$  0.5 mm., margins entire, apex rounded or obtuse, rarely bidentate. Cells large and small mixed, upper cells 18-27  $\mu$ , basal cells 22-44  $\mu$ ; walls thickened, trigones distinct, large in the basal region. Amphigastria distant, orbicular to orbicular-reniform, broader than long, up to 0.5 mm. broad, base slightly decurrent, margins entire, apex entire, emarginate, or with a distinct notch, lobes when present obtuse or rounded.

Plate XIII, figures 10-13.

Hab. On rocks.

Distrib. *Ahuas-Silrundi* Road, 8-10,000 ft.

*Note.*—Sometimes the leaves and the amphigastria bear long tail-like processes consisting of bundles of fine fibres arising from the apical cells.

\* \* \* \* \*

### XII. CEPHALOZIA Dum.

*Cephalozia* Dum., Rec. d'obs., p. 18 (1835).

Plants usually small, pale to dark green or brownish. Stem simple or with a few branches, the branches all postical, flagellæ frequently present. Leaves distant, obliquely inserted, succubous,

flat or somewhat channelled, generally 2-lobed, the margins entire. Amphigastria absent or small. Andrœcia spicate or amentiform, bracts longer than the leaves, mon-androus. Female inflorescence generally on short branches, occasionally at the apex of the main stem, bracts larger than the leaves, three pairs; bracteoles always present, free or connate only at the base with the bracts. Perianth elongate, tri- or pluri-plicate, in the former case odd angle postical, the mouth contracted, shortly lobed, lobes variously armed. Capsule longly exserted, the wall of two layers of cells, inner layer with semi-annular bands. Pedicel of the capsule usually composed of 8 outer cells and 4 smaller inner cells. Spores small, reddish brown. Elaters short, bispiral.

## 52. *Cephalozia Gollani* St.

*Cephalozia Gollani* St., Sp. Hep., Vol. III, p. 304 (1907).

Monœcious, small, tufted, in light green or reddish patches on rocks. Stem 8–12 mm. long with postical branches and small-leaved flagellæ. Rhizoids long, hyaline. Leaves imbricate, obliquely inserted by a long base, patent, directed upwards, dorsally concave, quadrate-ovate, 0.6 mm. long and 0.6 mm. broad at the base,  $\frac{1}{4}$ – $\frac{1}{3}$  bilobed, notch obtuse or rounded, broad or narrow, lobes convergent, usually unequal, especially the posterior one, tapering from a broad base, entire, acute. Upper cells  $50\text{--}68\ \mu \times 36\text{--}45\ \mu$ , basal cells  $72\text{--}79\ \mu \times 50\text{--}65\ \mu$ , often the cells polygonal, isodiametric; walls slightly thickened, trigones not at all thickened. Amphigastria absent. Andrœcia terminal, compact, elliptic, bracts about five pairs. Involucral bracts closely applied to the perianth, three pairs, lowermost small like the leaves, middle ones larger, uppermost much larger than the leaves, outline and lobing like the leaves. Bracteoles: lowermost minute, middle larger and ligulate entire, uppermost very large, deeply-bifid like the bract with long lanceolate lobes. Perianth oblong, longly exserted, pluri- or 3-plicate, in the latter case two carinæ antical and one postical,  $\frac{1}{3}$ – $\frac{1}{2}$  lobed, lobes laciniate at the tip.

Plate XIII, figures 14–18.

Hab. On moist rocks.

Distrib. Garhwal.

## FAMILY VIII. LOPHOZIACEÆ.

(Epigonantheæ Spr.).

Plants medium or small. Stem irregularly branched, very rarely pinnate, branches almost always lateral. Leaves succubous or transversely inserted, entire or 2-lobed, sometimes 3-5-lobed. Amphigastria generally absent or very small, very rarely large. Inflorescence generally terminal on the main shoots. Male bracts 1-10-androus. Perianth (when present) compressed from the sides, cylindrical, ovate or trigonous with the third angle always antical. Capsule mostly ovate or cylindrical, 4-valved to the base.

## Key to the genera.

1	{	Leaves two- or more-lobed or toothed ..	2	
		Leaves obtuse and entire, neither lobed nor toothed .. .. .	5	
2	{	Leaves lobed, not toothed .. .. .	3	
		Leaves not lobed, toothed .. .. .	4	
3	{	Leaves almost longitudinally inserted, amphigastria always present .. ..		<i>Lophocolea</i>
		Leaves obliquely inserted, amphigastria usually absent .. .. .		<i>Lophozia</i>
4	{	Amphigastria always absent .. .. .		<i>Plagiochila</i>
		Amphigastria present .. .. .		<i>Chiloscyphus</i>
5	{	Amphigastria present, bilobed .. .. .		<i>Chiloscyphus</i>
		Amphigastria absent or small .. .. .	6	
6	{	Leaves opposite .. .. .		<i>Southbya</i>
		Leaves alternate .. .. .	7	
7	{	Laciniate bracts and bracteoles always present .. .. .		<i>Jamesoniella</i>
		Bracteoles usually absent, if present not laciniate .. .. .	8	
8	{	Mouth contracted, ciliate .. .. .		<i>Solenostoma</i>
		Mouth not contracted, wide .. .. .		<i>Jungermannia</i>

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## XIII. CHILOSCYPHUS Corda.

*Chiloscyphus* Corda in Opiz, Beitr. I, p. 651 (1829).

Plants generally green, sometimes brown, laxly caespitose on soil or on bark. Stem irregularly branched, branches lateral.



Rhizoids in tufts from the bases of the amphigastria. Leaves succubous, alternate or opposite, nearly longitudinally inserted, decurrent antically, generally entire though bi- or pluri-dentate in some species. Amphigastria always present, usually bifid and with a tooth on one or both sides. Andrœcia intercalary on the stem or on long branches, bracts resembling the leaves but saccate with a small incurved lobule at the base of the antical margin. Female inflorescence on very short lateral branches. Bracts in a few pairs, much smaller than the leaves, entire or 2-3-lobed. Perianth campanulate with a wide 3-lobed mouth, the lobes entire or dentate. Capsule longly pedicellate, ovate, wall of several layers of cells, cells of the innermost layer with semi-annular bands. Spores small, brown, smooth or rough. Elaters laxly bispiral.

*Key to the species.*

- |   |   |   |    |                        |
|---|---|---|----|------------------------|
| 1 | { | Amphigastria large, usually entire              | .. | <i>C. inflatus</i>     |
|   | { | Amphigastria small, bilobed                     | .. | 2                      |
| 2 | { | Leaves pluri-dentate                            | .. | <i>C. argutus</i>      |
|   | { | Leaves entire                                   | .. | 3                      |
| 3 | { | Leaves not or slightly imbricate, semi-circular |    |                        |
|   |   | to sub-quadrate                                 | .. | <i>C. polyanthus</i>   |
|   | { | Leaves more or less closely imbricate, quad-    |    |                        |
|   |   | rate to oblong or oval                          | .. | 4                      |
| 4 | { | Leaves closely imbricate, quadrate to oblong    |    | <i>C. himalayensis</i> |
|   | { | Leaves slightly imbricate, oblong               |    | <i>C. campanulatus</i> |

53. *Chiloscyphus inflatus* St.

*Chiloscyphus inflatus* St., Sp. Hep., Vol. III, p. 206 (1907).

Sterile, medium, deep brown, slender, laxly caespitose, mixed with mosses and other liverworts. Stem 2-4 cm. long, simple or sparsely branched. Rhizoids in tufts from the bases of the amphigastria. Leaves secund (all directed upwards), closely imbricate, more or less semi-circular, up to 1.5 mm. × 1.25 mm., opposite, inserted by a long straight base, antically decurrent, entire, rounded. Cells circular, median about 30  $\mu$  in diameter, some larger, others smaller; trigones acute, prominent, walls rather thick; a few basal cells

elongated,  $54\ \mu \times 28\ \mu$ . Amphigastria large (smaller than the leaves) fused with the leaves on both sides at the base, appressed, sub-orbicular, entire or very shortly bilobed at the apex, lobes small, acute or obtuse, sometimes with a tooth on each side near the middle or the lobes and teeth small, obscure, rounded, occasionally the amphigastria with several subequal small lobes or coarse teeth.

Plate XIV, figures 1-4.

Hab. On rocks.

Distrib. *Chandar Tal*, 12,000 ft. (Gamble, 1894); *Kidar Kanta*, 12,000 ft. (Duthie, 1879); Above *Jalla* (Ganges Valley), 11-12,000 ft. (Duthie, 1881) (Herb., F.R.I., Dehra Dun); *Awas-Silrundi Road*, 8-10,000 ft.

#### 54. *Chiloscyphus argutus* Nees.

*Chiloscyphus argutus* Nees, Syn. Hepat., p. 183 (1844).

Sterile, brownish green, dense depresso-caespitose, mixed with other liverworts. Stem 4-5 cm. long, branched. Rhizoids scarce. Leaves alternate, plano-distichous or directed upwards a little, slightly imbricate, quadrate to rectangular or ovate-quadrate, up to  $1.75\ \text{mm.} \times 1.5\ \text{mm.}$ , antical base slightly decurrent, margins entire, apex broad with many coarse teeth. Upper cells  $15-20\ \mu$  (mostly  $18\ \mu$ ), basal  $40-54\ \mu \times 30-36\ \mu$ ; walls and trigones uniformly thickened. Amphigastria distant, small, as broad as the stem, base broad, hardly decurrent, bifid to about the middle, with a rounded sinus, lobes lanceolate, divergent, each usually with a tooth on the outer side.

Plate XIV, figures 5-7.

Hab. On rocks or on soil.

Distrib. *Churah* (Chamba), 4,000 ft.; Western Himalayas.

#### 55. *Chiloscyphus himalayensis* St.

*Chiloscyphus himalayensis* St., Sp. Hep., Vol. III, p. 209 (1907).

Monœcious or diœcious, pale green, flaccid, laxly caespitose on and among mosses or on moist soil. Stem about 3 cm. long, green, delicate, simple or slightly branched. Rhizoids in small

tufts from the bases of the amphigastria. Leaves alternate, closely imbricate, plano-distichous or directed upwards, quadrate to quadrate-oblong or ovate-oblong, up to 1.5 mm.  $\times$  1.25 mm. at the base, fixed by a long straight base, antically slightly or not at all decurrent, margins entire, apex rounded, occasionally truncate or with a shallow notch. Upper cells 24–36  $\mu$ , basal cells 54–58  $\mu$   $\times$  30–45  $\mu$ , polygonal; walls slightly thickened, trigones not thickened. Amphigastria small, quadrate to ovate-lanceolate,  $\frac{1}{2}$ – $\frac{2}{3}$  bifid, lobes divergent from an acute or slightly rounded sinus, lanceolate, acute, often with a tooth on the outer side. Androecia terminal or intercalary, 3–9 pairs of bracts similar in shape and size to the leaves, saccate with an incurved lobule at the antical base, bracts mon-androus. Involucral bracts one pair, smaller than the leaves, elliptic-oblong,  $\frac{1}{2}$  bifid, lobes convergent, ovate-lanceolate, acute or acuminate; bracteoles similar, smaller. Perianth ovate-campanulate, mouth wide, bounded by three lobes, lobes broadly triangular, toothed, obtuse. Seta up to 20 mm. long, thin, delicate. Capsule large, deep brown, broadly oval. Spores tetrahedral, smooth, reddish brown, 13  $\mu$ . Elaters concolorous, bispiral, about 160  $\mu$  long.

Plate XIV, figures 8–14.

Hab. On moist rocks and soil.

Distrib. Mussoorie.

### 56. *Chiloscyphus polyanthus* (L.) Corda.

*Jungermannia polyanthos* L., Sp. Pl. ed. 2, p. 1597 (1762).

*Cheiloscyphos polyanthos* Corda in Opiz, Beitr. I, p. 651 (1829).

Dioecious, medium, in thin flat light or yellow green patches on stones actually under water or on moist soil (in the latter case patches laxly caespitose). Stem 2 cm. or more long, simple or sparsely branched. Leaves alternate, slightly or not at all imbricate, plano-distichous, semi-circular to subquadrate, up to 1.25 mm. in diam., antical base more or less decurrent, margin entire, apex rounded. Upper cells about 28  $\mu$ , basal cells 50–60  $\mu$   $\times$  25–36  $\mu$ ; walls thin, trigones absent. Amphigastria very small, distant, appressed, oblong-lanceolate, apex  $\frac{1}{2}$ – $\frac{2}{3}$  bilobed, sinus narrow, lobes subulate. Bracts and bracteoles closely appressed

to the perianth. Bracts small, ligulate, entire, obtuse; bracteoles small, ligulate, to about  $\frac{1}{2}$  bilobed, lobes narrow, acute. Perianth ovate, mouth large, to about  $\frac{1}{2}$  divided into three lobes, lobes entire, rounded. Capsule shortly pedicellate, oval.

Plate XV, figures 1-3.

Hab. On moist rocks or on soil and often actually under running water.

Distrib. Mussoorie; Alwas; Silrundi; Dalhousie-Khajiar Road.

### 57. *Chiloscyphus campanulatus* St.

*Chiloscyphus campanulatus* St., Sp. Hep., Vol. III, p. 208 (1907).

Diœcious, small, pale green, laxly caespitose. Stem about 2.4 cm. long, delicate, flaccid, sparsely branched. Leaves imbricate, patent-divergent, broadly ovate, up to 1.5 mm. long and 1 mm. broad, entire, rounded. Upper cells mostly 20  $\mu$  (though some larger), basal 60-80  $\mu \times$  28-40  $\mu$ ; walls thin, trigones absent. Amphigastria small, apex bilobed, notch v-shaped, lobes narrow, acute, divergent. Andrœcia intercalary, bracts 5-6 pairs, similar to the leaves but for the antical lobule which covers the antheridium. Involucral bracts in two pairs, ovate-lanceolate, entire, acute; bracteoles two, oval, entire, apex notched, notch rounded, lobes broad, rounded. Perianth on thick short lateral branches, campanulate, mouth broad, to about  $\frac{1}{2}$  divided into three lobes, lobes entire or with numerous small teeth. Capsule long, oval. Spores golden yellow, smooth, 12  $\mu$ . Elaters concolorous, bispiral, 160  $\mu$ .

Plate XV, figures 4-8.

Hab. On moist soil.

Distrib. Mussoorie (Gollan, 1895) (Herb., F.R.I., Dehra Dun).

The following species of *Chiloscyphus* has been described by Stephani but has not been seen by us.

### 58. *Chiloscyphus Gollani* St.

*Chiloscyphus Gollani* St., Sp. Hep., Vol. III, p. 209 (1907).

Diœcious, medium or large, pale, flaccid. Stem up to 5 cm. long, sparsely branched, thin, pale, weak, prostrate, apex long

procumbent. Leaves 2 mm. long, alternate, imbricate, oblique, patent, angle  $67^\circ$ , slightly concave; distichous; broadly ovate, entire, or apex obliquely retuse or unequally obtusely bilobed. Upper cells  $36\ \mu$ , basal cells  $54\ \mu \times 45\ \mu$ ; trigones nil. Amphigastria small, as broad as the stem, free, oblong, transversely inserted, base with a spine on each side, apex deeply bifid, lobes narrow, lanceolate, spreading. Perianth obcuneate, campanulate, to about the middle trilobed, lobes slightly acute, bilobed or occasionally with a few teeth, teeth strong, acute. Bracts appressed, small, oblong, more or less deeply bifid, lobes acute, entire. Bracteoles appressed, subrotund, trilobed to about the middle, lobes ovate, acute. Andrœcia in the middle of the stem, bracts about five pairs, slightly smaller than the leaves, antical lobule small, inflated, acute or obtuse.

Hab. Himalayas, *Mussoorie* (Gollan).

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#### XIV. LOPHOCOLEA Dum.

*Lophocolea* Dum., Rec. d'obs., p. 17 (1835).

Plants medium or small, green, delicate and flaccid, laxly caespitose. Stem creeping, irregularly branched. Rhizoids colourless, arising from the bases of the amphigastria. Leaves succubous, nearly longitudinally inserted, antically more or less decurrent, spreading, entire or bifid. Amphigastria usually free, bifid, with a tooth on each side of the base, occasionally plurifid. Andrœcia longly spicate at the middle or the end of the branches or below the perianth, bracts with an inflated antical lobule, antheridia solitary. Female inflorescence terminal on the main stem or branches. Bracts resembling the leaves, often more dentate or ciliate. Perianth commonly oblong, trigono-prismatic, the keels frequently winged, the wide mouth trilobate with the lobes generally bifid, denticulate or ciliate. Capsule longly pedicellate, ovate, wall of many layers of cells. Spores small, brown, smooth or muriculate. Elaters laxly bispiral.

*Key to the species.*

- |   |   |   |    |                        |
|---|---|---|----|------------------------|
| 1 | { | Plants small, gemmæ abundant              | .. | <i>L. minor</i>        |
|   | { | Plants larger, gemmæ not common           | .. | 2                      |
| 2 | { | Upper stem leaves usually entire or emar- |    |                        |
|   |   | ginate                                    | .. | <i>L. heterophylla</i> |
|   | { | Leaves on the stem all alike, bilobed     | .. | 3                      |
| 3 | { | Angles of the perianth not winged         | .. | <i>L. bidentata</i>    |
|   | { | Angles more or less winged                | .. | <i>L. alata</i>        |

**59. *Lophocolea bidentata* (L.) Dum.**

*Jungermannia bidentata* L., Sp. Pl. 2, p. 1598 (1762).

*Lophocolea bidentata* Dum., Rec. d'obs., p. 17 (1835).

Monœcious or diœcious. In yellowish green patches. Stem about 1 cm. long, procumbent, simple or sparsely branched. Rhizoids in small tufts from the underside of the stem near the bases of the amphigastria. Leaves slightly or not at all imbricate, obliquely inserted, patent, flat or directed upwards, quadrate-oblong, up to 1.25 mm.  $\times$  0.75 mm., antical basal portion longly decurrent, postical not so, margin entire, apex broad, shortly bilobed, sinus broad, generally lunate, lobes cuneate to lanceolate, acute or acuminate, the antical usually smaller, occasionally one lobe obsolete and rarely the apex tridentate. Upper cells 25–28  $\mu$ , basal cells 40–50  $\mu \times$  25–28  $\mu$ ; walls thin, trigones minute. Amphigastria small, distant, spreading, divided to below the middle into two linear-lanceolate divergent lobes, usually with an acute lobe or a small process on one or both sides. Andrœcia terminal on main or short shoots, spicate, bracts 6–9 pairs, smaller than the leaves, closely imbricate, unequally and acutely 2-3-lobed, saccate at the antical base, mon-androus. Involucral bracts larger than the leaves, oblong, margins entire or with a tooth on either side, shortly bilobed, sinus broad or narrow, lobes triangular to lanceolate, acute or acuminate. Bracteoles much larger than the amphigastria, oblong, like the leaves but smaller. Perianth oblong, sharply trigonous (not winged), mouth broad, trilobed to about the middle, lobes broadly triangular, margins coarsely dentate-ciliate, each lobe shortly bilobed at the apex.

Plate XVI, figures 1-8.

Hab. On moist soil.

Distrib. *Mussoorie*.

60. *Lophocolea heterophylla* (Schrad.) Dum.

*Jungermannia heterophylla* Schrad., Journ. für d. Bot. 5, p. 66. (1801).

*Lophocolea heterophylla* Dum., Rec. d'obs., p. 17 (1835).

Monœcious, in green or brown patches. Stem up to 2 cm. long, sparsely and irregularly branched, the branches often bearing small distant bilobed leaves. Rhizoids in tufts from the bases of the amphigastria. Leaves alternate, slightly or closely imbricate, obliquely inserted, usually directed upwards, lower leaves smaller, upper leaves larger, quadrate to subrectangular, up to 1 mm. long and usually up to 0.75 mm. broad, margins entire, apex in the lower leaves shortly bilobed, in the upper leaves retuse or truncate; sometimes all the leaves bilobed, notch lunate, lobes acute or obtuse. Upper cells about 25  $\mu$ , basal cells up to 54  $\mu \times 36 \mu$  (sometimes much smaller); walls thin, trigones thin, prominent. Amphigastria spreading, bifid to below the middle (sometimes nearly to the base), lobes lanceolate, acute, with a tooth on either side near the base. One sub-involucral innovation present. Bracts of the same size as the leaves, shortly bilobed, quadrate-oblong. Bracteoles bifid, margins entire or coarsely toothed. Perianth trigonous, exserted, oblong, to about  $\frac{1}{2}$  divided into three lobes, lobes usually more or less coarsely dentate.

Plate XVI, figures 9-14.

Hab. On rocks and bark.

Distrib. *Mussoorie*.

Note.—The species is generally described as monœcious but we have not seen any antheridia in our specimens.

61. *Lophocolea minor* Nees.

*Lophocolea minor* Nees, Hepat. Eur., II, p. 330.

Sterile, delicate, on bark or moist soil, in small dense light green tufts closely applied to the substratum. Stem up to 1 cm.

long, sparsely branched. Rhizoids long, hyaline, in small tufts from the bases of the amphigastria. Leaves alternate, slightly spreading, distant or slightly imbricate, quadrate to subrectangular, up to 0.5 mm.  $\times$  0.4 mm., almost longitudinally inserted, antical basal portion slightly decurrent, margins entire, almost always gemmiferous, apex bilobed to  $\frac{1}{2}$ – $\frac{1}{3}$ , lobes broadly triangular, more or less divergent. Cells about 30  $\mu$ ; walls thin, trigones small, distinct. Amphigastria small, distant, as broad as the stem, deeply bilobed, lobes narrow, lanceolate, with or without a tooth on the outer side. Gemmæ unicellular, in short simple or branched filaments, the latter forming more or less globose clusters.

Plate XVII, figures 1-2.

Hab. On bark and moist rocks.

Distrib. Mussoorie (fairly common); Lahul; Western Himalaya, locality not noted.

*Note.*—The plant can easily be recognised by its small size and bilobed leaves which are almost always gemmiferous at the margins of the lobes.

## 62. *Lophocolea alata* Mitt. ex Larter.

*Lophocolea alata* Mitten ex Larter, Trans. Devon. Ass. Sc. Litt. Art., p. 285 (1906).

Dioecious, medium or small, creeping on the surface of soil. Stem about 1 cm. long, irregularly and sparsely branched. Rhizoids in tufts from the bases of the amphigastria. Leaves alternate, closely imbricate, obliquely inserted, erecto-patent, directed upwards, ovate to ovate-oblong, up to 1.25 mm. long and 1.0 mm. broad at the base, antical base decurrent, antical margin recurved, postical straight, apex bilobed, sinus lunate, lobes more or less unequal, tapering from a broad base, acuminate, divergent. Upper cells 25–36  $\mu$ , basal cells up to 50  $\mu \times$  40  $\mu$ , many smaller; walls and trigones slightly thickened. Amphigastria small, distant, apex to about  $\frac{1}{2}$  bilobed, lobes long, narrow, setaceous with or without a tooth on the outer side. Bracts like the leaves but larger, sinus acute. Bracteoles smaller than the bracts, otherwise similar. Perianth longly exserted, oblong, trigonous, angles more or less



winged, mouth shortly 3-lobed, lobes again irregularly lobed, spinous-dentate or spinous-lacerate. Capsule oblong-oval, longly pedicelled.

Plate XVII, figures 3-6.

Hab. On moist soil.

Distrib. *Dalhousie*.

\* \* \* \* \*

## XV: PLAGIOCHILA Dum.

*Plagiochila* Dum., Rec. d'obs., p. 14 (1835).

Plants large, rarely small, often robust, on soil, rocks or on bark, laxly caespitose, green or reddish. Rhizome stout, creeping, leafless or with a few small leaves, with numerous rhizoids. Stem firm, reddish or almost black, rarely pale. Branches without rhizoids, ascending or procumbent, dichotomously branched or dendroid, branches arising from the postical angle of the leaves. Leaves almost always large, succubous, alternate, widely spreading, antical margin decurrent, reflexed, nearly straight, postical margin arcuate, rotundate, sometimes semi-circular, reflexed towards the base, margin dentate or spinous-dentate or ciliate, very rarely entire. Amphigastria usually absent. Dioecious. Androecia spicate, linear or fusiform, terminal or intercalary, bracts smaller than the leaves, closely imbricate, saccate at the base, 1-10-androus, usually with only two or three antheridia. Bracts free, 2-3 pairs, similar to the leaves but often broader and more dentate, appressed to the perianth. Perianth laterally compressed in the upper part, inflated in the lower part, mouth truncate or rotundate, variously armed. Capsule shortly pedicellate, oval-globose, 4-valved to about the base, wall many-layered, often very thick and spongy, inner layer with semi-annular bands. Elaters bispiral. Spores small, smooth or rough.

*Note.*—*Plagiochila* is one of the few very large genera of the liverworts. Stephani in his monograph has recognised over 800 species of this genus. Most of them are tropical and have very small ranges of distribution. The plants as they grow are so conspicuous that no collector of liverworts can miss them but the

question of determining the species presents a difficult problem for the taxonomist. The various attempts to arrange the species of this genus have been reviewed by Stephani.

The characteristic appearance of the species depends upon how the leaves are inserted on the stem. They may be drooping both in the living and the dry condition or they may be opposite or alternate making angles of various degrees with the stem but not drooping. The first two are small, well-defined groups, but the large majority of the species come under the third group.

The sex organs are rather rare and even if present do not afford suitable basis of classifying the species. One has, therefore, to base the grouping on the vegetative characters alone. Large groups are made according to the attachment of the leaves on the stem (not on the branches), i.e. whether the antical base is decurrent and the degree of it, the postical base is ampliate or not, decurrent or not and so on. Within these larger groups smaller groups are based on such differential characters as the type of branching present, the shape of the leaves, the number and the peculiarities of their teeth, the size of the leaf cells, and the nature of local thickenings in the cell walls.

*Key to the species.*

- |   |   |  |       |                      |
|---|---|--|-------|----------------------|
| 1 | { | Leaves entire or faintly toothed                 | ..    | <i>P. sp. A</i>      |
|   | { | Leaves toothed, teeth long or short              | ..    | 2                    |
|   | { | Postical base of the leaf covering the stem      |       |                      |
| 2 | { | and more or less crossing it                     | .. .. | 3                    |
|   | { | Postical base of the leaf covering a part of the |       |                      |
|   | { | stem and never crossing it                       | .. .. | 4                    |
|   | { | Antical base shortly decurrent, postical not     |       |                      |
| 3 | { | decurrent  | .. .. | <i>P. Mittenii</i>   |
|   | { | Antical base longly decurrent, postical fairly   |       |                      |
|   | { | decurrent  | .. .. | <i>P. sp. B</i>      |
| 4 | { | Postical base not decurrent                      | .. .. | 5                    |
|   | { | Postical base decurrent                          | .. .. | 6                    |
| 5 | { | Teeth small                                      | .. .. | <i>P. similana</i>   |
|   | { | Teeth large, coarse                              | .. .. | <i>P. ferruginea</i> |

- 6 { Antical base longly decurrent, teeth coarse  
and numerous .. .. . *P. accedens*  
Antical base shortly decurrent, teeth shorter  
and less numerous .. .. . *P. mundaliensis*

### 63. *Plagiochila mundaliensis* St.

*Plagiochila mundaliensis* St., Sp. Hep., Vol. II, p. 340 (1903).

Sterile, medium, flaccid, pale green, mixed with mosses, cæspitose. Stem 3-4 cm. long, sparsely branched. Rhizoids few, brown, confined to the base of the stem. Leaves imbricate, patent, oblique, ovate or ovate-triangular, 2.5 mm. long, lower  $\frac{1}{2}$  dilated, base narrow, sinuous, antical decurrent on the stem, postical slightly ampliate, rounded, decurrent on the stem, antical margin almost straight, entire or with 3 or 4 teeth below the apex, teeth small, directed forward; postical margin more or less convex, base entire rest irregularly dentate, teeth 6, sometimes fewer. Upper cells mostly  $28\ \mu$  (some  $20-24\ \mu$ ), walls thick, trigones large, sub-nodulose; basal cells  $44-76\ \mu \times 28-40\ \mu$ , walls thick, trigones large, subnodulose.

Plate XVII, figures 7-12.

Hab. i On rocks.

Distrib. *Mundali* (Jansar) 8,000 ft. (Gamble, 1892) (Herb., F.R.I., Dehra Dun).

### 64. *Plagiochila simlana* Mitt.

*Plagiochila simlana* Mitten; St., Sp. Hep., Vol. II, p. 329 (1903).

Sterile, small, flaccid, green, densely cæspitose, in pure patches. Stem about 2 cm. long, simple, rarely branched, branches small-leaved. Rhizoids numerous, hyaline, confined to the basal region of the stem. Leaves more or less imbricate, broadly ovate, 2 mm. long, patent-divergent, base narrow, sinuous, antical base shortly decurrent, postical dilated, covering the stem; antical margin straight or narrowly incurved, apical portion toothed, teeth small, postical margin near the base entire, rest with 11 or 12 teeth, teeth small, spreading, a few large. Upper cells  $18\ \mu$ , walls thicken-

ed, trigones not conspicuous, basal cells  $44\ \mu \times 28\ \mu$ , rectangular, walls thick, trigones subnodulose.

Plate XVIII, figures 1-6.

Hab. On rocks.

Distrib. *Bhuj Koti* (Jansar), 8,000 ft. (Gamble, 1894) (Herb., F.R.I., Dehra Dun).

#### 65. *Plagiochila Mittenii* St.

*Plagiochila Mittenii* St., Bull. Herb. Boiss., 1897, p. 83; Sp. Hep., Vol. II, p. 337 (1903).

*Plagiochila ambigua* Mitten, Jour. Proc. Linn. Soc., Vol. V, p. 96 (1861).

Sterile, medium, deep brown, densely caespitose, mixed with mosses and liverworts. Stem about 4 cm. long, sparsely branched, branches either aphyllous or only with small ones. Rhizoids confined to the basal region of the stem or the aphyllous branches. Leaves oblique, patent, imbricate, decurved, symmetrical, ovate, 3 mm. long, base narrow, flat, antical base decurrent on the stem, postical rounded, slightly decurved, antical margin straight or slightly incurved, entire or with 3-4 teeth; postical with almost an entire rotundate base, densely spinose, spines unequal in size, large and small irregularly mixed, strongly spreading. Upper cells  $24-28\ \mu$ , walls thin, trigones large, acute; basal cells  $48-56\ \mu \times 24-28\ \mu$ , walls and trigones equally thickened. Leaves on the branches small, entire.

Plate XVIII, figures 7-12.

Hab. On rocks.

Distrib. *Kaj Nag*, 12-13,000 ft. (Duthie, 1892) (Herb., F.R.I., Dehra Dun).

#### 66. *Plagiochila ferruginea* St.

*Plagiochila ferruginea* St., Sp. Hep., Vol. II, p. 364 (1903).

Sterile, medium, light brown to reddish brown, mixed with mosses, densely caespitose. Stem brown to dark brown, simple or once or twice forked, with small-leaved flagellæ. Leaves more or less imbricate, patent, asymmetrical, quadrate-ovate, up to 2.5

mm.  $\times$  1.5 mm., base narrow, antical base longly decurrent on the stem, postical more or less ampliate, covering the stem but not crossing it, antical margin straight, generally rolled inwards, tridentate below the apex, postical margin more or less convex, irregularly serrate, teeth coarse or fine, sometimes the margin entire. Upper cells 15-22  $\mu$ , basal cells 50-70  $\mu \times$  25-35  $\mu$ ; walls slightly thickened, trigones thickened, sometimes thick and nodulose in the upper and middle portion but indistinct at the base.

Plate XIX, figures 1-6.

Hab. On soil.

Distrib. *Mussoorie* (Duthie, 1892) (Herb., F.R.I., Dehra Dun);  
*Dalhousie-Khajiar Road*.

#### 67. *Plagiochila accedens* St.

*Plagiochila accedens* St., Sp. Hep., Vol. II, p. 341 (1903).

Dioecious, medium, light brown. Stem 3-4 cm. long, sparsely branched, some of the branches flagelliform. Leaves slightly or not at all imbricate, patent, asymmetrical, oblong-ovate, up to 2.50 mm.  $\times$  1.75 mm., base narrow, antical base longly and narrowly decurrent on the stem, postical ampliate, covering but not crossing the stem, shortly and narrowly decurrent on the stem, antical margin straight, revolute, lower  $\frac{1}{2}$ - $\frac{2}{3}$  entire, upper with 3-4 teeth, postical margin convex with 10-14 teeth, teeth long and short irregularly mixed, up to 7 cells long, triangular-lanceolate from a broad base which is up to 4 cells broad. Upper cells 18-30  $\mu$  (usually 22  $\mu$ ), basal cells 50-70  $\mu \times$  25-30  $\mu$  (many much smaller); walls rather thin, trigones large, thickened. Androecia intercalary, bracts about 4 pairs, smaller than the leaves, imbricate, saccate, mon-androus; antheridia globular, long-stalked. Involucral bracts resembling the leaves but larger, coarsely toothed. Perianth not exerted, laterally compressed, mouth wide, sub-bilipped (with notches at the edges of the compressed perianth) coarsely dentate-laciniate.

Plate XIX, figures 7-12.

Hab. On soil.

Distrib. *Mussoorie* (Duthie, 1892) (Herb., F.R.I., Dehra Dun);  
*Garhwal*; *Dalhousie*.

68. *Plagiochila* sp. A.

Dioecious, small, reddish brown, caespitose. Stem sparsely branched, up to 3 cm. long, usually with one or two sub-floral innovations. Leaves patent, imbricate to lax, suborbicular, up to 1.5 mm. long and broad, symmetrical, base narrow, antical base longly and narrowly decurrent on the stem, postical rounded, partly covering the stem, slightly and narrowly decurrent on the stem, margins entire or the upper part faintly and distantly toothed especially in the leaves towards the apex; posterior margin more or less straight, reflexed; teeth 1-celled. Upper cells 18–22  $\mu$ , basal cells up to 35–45  $\mu \times 20$ –28  $\mu$ , walls thin, trigones distinct. Bracts similar to the leaves but larger and distinctly toothed, teeth all alike, 1–3-celled. Perianth only slightly exerted, inflated in the lower part, laterally compressed in the upper part, mouth wide, oblique, truncate or shortly bilobed, lobes usually toothed, the teeth in older condition often disintegrated.

Plate XX, figures 1–7.

Hab. On soil.

Distrib. *Chamba-Barmaur Road.*

69. *Plagiochila* sp. B.

Sterile, medium or large, robust, deep brown or greenish brown. Stem dark brown below, brown above, 6–8 cm. long, sparsely branched. Leaves erecto-patent, imbricate, asymmetrical, ovate, up to 2.5 mm. long and up to 2 mm. broad at the base, base narrow, antical basal portion longly decurrent on the stem, postical ampliate, rounded, usually crossing the stem, reflexed, narrowly decurrent on the stem, antical margin rolled inwards, straight or slightly concave, usually entire, sometimes, however, with a few teeth, postical margin rounded, entire at the base, rest with 8–10 spines, spines coarse, long and short irregularly mixed. Upper cells 18–25  $\mu$ , walls slightly thickened, trigones distinct; basal cells 34–51  $\mu \times 20$ –30  $\mu$ , walls thick, trigones large, nodulose.

Plate XX, figures 8–13.

Hab. On rocks.

Distrib. *Mussoorie*; *Kumaon*; *Simla*; probably also from *Dalhousie-Chamba Road.*

*Note.*—The teeth of the leaves on the older branches are usually not distinct. They get broken and disintegrated but they are perfectly conspicuous on the well-developed leaves of the younger branches.

The following species of *Plagiochila* have been described by Stephani but have not been seen by us.

#### 70. *Plagiochila himalayensis* St.

*Plagiochila himalayensis* St., Sp. Hep., Vol. II, p. 331 (1903).

Diœcious, medium, rigid, yellowish green, densely cæspitose. Stem up to 4 cm. long, simple or slightly branched, strong, fleshy and fragile. Leaves 2 mm. long, approximate, decurved-homomallous, strongly concave, slightly decurrent on both sides, postically amplate, reflexed, slightly covering the stem, quadrate-rotundate, antical margin almost straight, entire, postical semicircularly curved from the base, entire or upper portion with a few teeth, apex broad, truncate or retuse, angulate or entire. Upper cells  $27\ \mu$ , trigones large, basal  $54\ \mu \times 27\ \mu$ , trigones much thickened. Bracts similar to the leaves, upper portion dentate, teeth remote, strong, short, acute, strongly spreading. Perianth half exserted, obovate, slightly compressed, mouth strongly truncate, regularly toothed, teeth small, acute.

Hab. Western Himalaya, Bashar (Gamble); Kashmir, *Tragbal Pass* (Duthie, 9,000 ft.).

#### 71. *Plagiochila Duthiana* St.

*Plagiochila Duthiana* St., Sp. Hep., Vol. II, p. 331 (1903).

Sterile, medium, low, strong, yellowish green, dense depressocæspitose. Stem up to 2 cm. long, thick, green, simple, decurved. Mature leaves 2.5 mm. long, approximate, obliquely spreading, angle  $45^\circ$ , slightly decurrent on both sides, margins highly revolute, subcylindrical, postical amplate, covering the stem, lower portion of the antical margin almost entire, above armed, rest subcircular, entire. Upper leaves similar, somewhat smaller, above often decurved. Upper cells  $18\ \mu$ , trigones narrow; basal  $54\ \mu \times 27\ \mu$ , walls thick.

Hab. Kashmir (Duthie, 9,000 ft.).

72. *Plagiochila cavifolia* St.

*Plagiochila cavifolia* St., Sp. Hep., Vol. II, p. 332 (1903).

Sterile, small, low, green, dense, depresso-caespitose. Stem up to 2 cm. long, simple or rarely with a few branches, base with rhizoids, upper procumbent. Leaves 2 mm. long, imbricate, antically and postically decurved, to about the middle and thence strongly concave, subinflated, subcircular, hardly decurrent, postical ampliate, broadly covering the stem and denticulate at that place, rest entire. Upper cells normally  $27\ \mu$ , irregular, occasionally much smaller; basal  $45\ \mu \times 27\ \mu$ ; trigones everywhere small, acute.

Hab. Kashmir, *Sonamerg* (Duthie).

73. *Plagiochila Gollani* St.

*Plagiochila Gollani* St., Sp. Hep., Vol. II, p. 368 (1903).

Sterile, medium, olive green or brown, subflaccid, commonly mixed with mosses or densely caespitose, terrestrial. Stem up to 7 cm. long, thin, weak, brown, simple or upper portion fascicled with a few branches, branches long spreading. Leaves imbricate, 3 mm. long, obliquely spreading, angle  $67^\circ$ , briefly decurrent on both sides, postical ampliate, broadly covering the stem, recurved, ovate-trigonus, symmetrical, base ampliate, apex  $\frac{1}{2}$  as broad, antical margin almost straight, entire or apical half with a few minute teeth, postical at the base semi-circular, slightly arcuate, slightly dentate, teeth below 12, short, broadly triangular, acute, strongly spreading, apex subtruncate with 5 equal teeth, teeth similar, slightly attenuated, sharp. Leaves on the branches as long as those on the stem but strongly spreading, apex half as broad as the base, postical very slightly ampliate, covering the stem, both margins almost entire, postical margin at the apex dentate-spinose. Upper cells  $27\ \mu$ , trigones small, acute; basal  $54\ \mu \times 27\ \mu$ , trigones large, acute.

Hab. Himalaya, *Mussoorie* (Gollan, Duthie).



74. *Plagiochila grata* St.

*Plagiochila grata* St., Sp. Hep., Vol. VI, p. 160 (1918).

Sterile, large, slender, rigid, yellowish, becoming brown with age; dense depresso-caespitose on bark. Stem up to 7 cm. long, with regular long branches, branches 3 cm. long, simple, upper ones slightly smaller. Leaves close, obliquely spreading, canaliculate-concave, ovate-trigonal, 3.5 mm. long, 2.75 mm. broad above the base, asymmetrical, upper margin at the base rotundate and almost straight above, regularly shortly dentate, lower margin slightly arcuate, with a few teeth below the apex, apex obtuse, arcuate. Upper cells  $18\ \mu \times 18\ \mu$ , trigones nil; basal  $36\ \mu \times 27\ \mu$ , trigones small.

Hab. *Simla* (Long).

75. *Plagiochila nana* St.

*Plagiochila nana* St., Sp. Hep., Vol. VI, p. 188 (1918).

Sterile, small, rigid, yellowish red, forming cushions on bark. Stem up to 2 cm. long, thick, strong, with a few long branches, branches frequently fasciculate. Leaves imbricate, obliquely spreading, strongly concave, subinvolute, ovate-trigonal, 3.5 mm. long, 2.75 mm. broad at the middle, asymmetrical, inserted by a small base, antical base shortly decurrent, upper margin strongly arcuate, upper portion straight, regularly shortly dentate, lower margin almost straight, in the lower part entire, upper similarly dentate, apex 0.75 mm. broad, emarginate-bifid, lacinæ small, triangulate, minutely denticulate, spreading. Upper cells  $18\ \mu \times 18\ \mu$ , basal  $36\ \mu \times 18\ \mu$ ; trigones large.

Hab. *Simla*, (Long).

Gola (Atti della R. Accad. delle Sci. di Torino, Vol. XLIX, 1914) has reported *Plagiochila asplenioides* Dum. from Kashmir, but we have not seen this. The following description is after Stephani (Sp. Hep., Vol. II, p. 319).

76. *Plagiochila asplenioides* (L.) Dum.

*Jungermannia asplenioides* L., Sp. Pl. II, 1597.

*Plagiochila asplenioides* (L.) Dum., Rec. d'obs., p. 14 (1835).

Dicecious, large or very large, robust, green, more or less densely tufted on ground. Stem up to 20 cm. long (usually 4-5 cm.) more or less branched, strong and rigid, lower portion brown, apex decurved, with numerous descending branches. Leaves imbricate or remote, 3 mm. long, obliquely spreading, angle  $58^\circ$ , distichous, margins decurved, concave, subsymmetrical, broadly obovate, postical base slightly ampliate, covering the stem, denticulate along the whole margin, teeth approximate, small, usually 2-celled, numerous, upper cells  $18\ \mu$ , trigones small; basal  $36\ \mu \times 18\ \mu$ , trigones large. Bracts larger than the leaves, suborbicular, lower portion entire, rest similarly armed. Perianth semi-exserted, compressed, obcuneate, mouth broadly truncate, irregularly denticulate, capsule long-pedicelled, oval. Spores brown,  $12\ \mu$ . Elaters concolorous, bispiral. Androecia intercalary, short, bracts 6-7 pairs, closely imbricate, above the middle denticulate.

Hab. Kashmir.

\* \* \* \* \*

## XVI. LOPHOZIA Dum.

*Lophozia* Dum., Rec. d'obs., p. 17 (1835).

Plants small to large, caespitose, generally more or less brown. Stem prostrate or ascending, more rarely erect, simple or slightly branched, frequently with sub-floral innovations. Rhizoids long, hyaline. Leaves alternate, succubous, obliquely inserted, young leaves semi-erect, adult ones more or less spreading, concave, generally 2-lobed, in some 3-many-lobed. Dicecious or monœcious. Androecia terminal or intercalary, bracts saccate at the base, frequently with an additional antical tooth or lobe. Involucral bracts nearly always larger than the leaves, generally more lobed and frequently dentate. Perianth longly exserted, ovate to cylindrical, nearly always plicate above, contracted at the apex, in a few with a beak. Capsule longly pedicellate, oval, the inner layer of wall with semi-annular thickenings. Spores small, rough. Elaters bispiral. Gemmæ frequent, usually angular.

*Key to the species.*

- |   |   |                     |
|---|---|---------------------|
| 1 | { Lobes toothed to spinous .. ..              | <i>L. incisa</i>    |
|   | { Lobes not toothed, apex rounded or acute .. | 2                   |
| 2 | { Lobes 2 .. ..                               | <i>L. alpestris</i> |
|   | { Lobes 3 .. ..                               | <i>L. sp.</i>       |

**77. *Lophozia alpestris* (Schleich.) Evans.**

*Jungermannia alpestris* Schleich., Hist. Musc. Hep. Prod., p. 80 (1815).

*Lophozia alpestris* Evans, Rhodora, p. 181 (1901).

Sterile, small, in dense tufts, simple or sparsely branched at the base. Stem brownish, 10–15 mm. (sometimes 20 mm.) long. Rhizoids long, hyaline, numerous, from the ventral side of the stem. Leaves imbricate, patent divergent, concave above in the young condition but margins often reflexed in the older condition, transversely inserted by a broad base, encircling half the stem, auriculate and undulate on both sides, suborbicular, up to 2 mm. in diameter, usually shortly 2-lobed, notch triangular, shallow, lobes divergent, apex rounded or obtuse. Upper cells 14–18  $\mu$ , walls and trigones uniformly thickened, basal 45–54  $\mu \times$  14–18  $\mu$ , walls rather thin, trigones not conspicuous; spherical clusters of dark brown gemmæ on the tips of the lobes of the leaves just below the apex. Gemmæ 2-celled, upper cells usually rounded, lower obovoid. Amphigastria absent.

Plate XXI, figures 1–5.

Hab. On the banks of streams, etc.

Distrib. Zaskar, 14–15,000 ft.; Gurdhar Pass, 14–15,000 ft.

**78. *Lophozia incisa* (Schrad.) Dum.**

*Jungermannia incisa* Schrad., Syst. Samml.-Krypt.-Gew. 2, p. 5 (1796).

*Lophozia incisa* Dum., Rec. d'obs., p. 17 (1835).

Diœcious, in compact dark brown depressed patches. Stem dark brown, short and thick, up to 15 mm. long, usually smaller, simple or sparsely branched. Rhizoids long, numerous, extending up to the apex of the stem, brownish. Leaves almost transverse,

quadrate, up to 1.50 mm.  $\times$  1.25 mm., half embracing the stem, opposite above and then fused antically, imbricate, lower leaves lax, alternate, subcomplicate, wavy, unequally bilobed, the upper plicate-crispate often forming a bud at the apex of the stem, usually shortly 3-lobed, lobes sometimes obscure, usually spinous, toothed, teeth long, unicellular. Upper cells 25–36  $\mu$ , basal up to 50  $\mu \times$  25  $\mu$ , walls thin, trigones prominent. Amphigastria absent. Gemmæ on the margins of the lobes.

Plate XXI, figures 6–9.

Hab. On moist rocks.

Distrib. *Alwas-Silrundi* Road, 10,000 ft.; Zanskar.

#### 79. *Lophozia* Sp.

Sterile. In loose brownish tufts. Stem up to 2 cm. long, dark brown, procumbent or ascending, sparsely branched. Rhizoids numerous, dense, colourless, extending up to the apex of the stem. Leaves smaller below, becoming gradually larger above, imbricate, patent, concave, almost transversely inserted, antical base ampliate, half encircling the stem, asymmetrical, broader than long, up to 2.25 mm. broad and up to 1.5 mm. long, conspicuously longitudinally folded in the outer half, margins in the lower part of the leaf a little wavy, usually unequally 3-lobed, lobes (sometimes obscure) rounded or with a short tooth at the apex. Cells rounded, upper and median cells 18–26  $\mu$ , basal cells longer up to 43  $\mu \times$  18  $\mu$ , walls thin, trigones large, nodulose. Amphigastria absent.

Plate XXII, figures 1–3.

Distrib. *Chamba-Pangi* Road, *Silrundi*, 10,000 ft.; *Gurdhar Pass*, 14–15,000 ft.

Mr. Nicholson who examined these specimens thinks that it is a new species.

The following species of *Lophozia* has been described by Gola but has not been seen by us.

#### 80. *Lophozia Piacenzai* Gola

*Lophozia Piacenzai* Gola, Atti Della R. Accad. delle sci. di Torino, Vol. XLIX (1914).

Dioecious, small, brown, caespitose, terrestrial. Stem up to 1 cm. long, sparsely branched, branches frequently flagelliferous, with sub floral innovations. Leaves obliquely inserted, arcuate-recurved, subsymmetrical, oblong-rectangulate, postical base slightly ampliate-rotundate, up to  $\frac{1}{2}$  lobed, sinus rotundate, obtuse, lobes broadly triangular. Upper cells  $25\ \mu$ , median  $40\ \mu$ , basal  $50\ \mu \times 22\ \mu$ ; trigones large, acute; cuticle smooth or subpapillose. Amphigastria small and always quite distinct, ovate, bifid to about the middle, lobes acute. Involucral bracts and bracteoles about twice as large as the leaves and amphigastria, rest similar, the lobes of the bracteole, however, with 1-2 teeth. Perianth (sterile) 3 mm. long, ovate-campanulate, mouth truncate laciniate, segments gemmiferous. Gemmæ at the tips of the sterile branches, brownish, 2-3-celled.

Hab. Kashmir.

\* \* \* \* \*

## XVII. JAMESONIELLA (Spruce) Schiffn.

*Jungermannia* subgenus *Jamesoniella* Spruce, Jour. Bot., pp. 26-29 (1876).

*Jamesoniella* Schiffn. in Engl. Und Prantl, Die Nat. Pflanzenf. I, 3, p. 82 (1893).

Plants medium or large, green, often reddish brown to purple. Stem usually ascending or erect with the apex incurved, often rigid, with sub-involucral innovations. Leaves alternate, succubous, entire, obliquely inserted and almost semi-amplexicaul, erect-connivent, ovate to subrotund. Amphigastria absent or minute. Dioecious. Andrecia terminal or intercalary, bracts saccate with an inflated antical lobule. Involucral bracts slightly larger than the leaves, more or less laciniate, bracteoles large, laciniate. Perianth (when fertile) longly exserted, oblong-ovate, deeply pluriplicate in the upper half, somewhat contracted at the wide mouth, mouth lobed.

### 81. *Jamesoniella elongella* (Tayl.) St.

*Jungermannia elongella* Tayl., Jour. Bot., p. 274 (1846).

*Jamesoniella elongella* St., Sp. Hep., Vol. II, p. 93 (1901).

Diœcious, medium, brown or purplish brown, cœspitose. Stem prostrate or procumbent, up to 2·5 cm. long, simple or sparsely branched, sub-floral innovations present. Rhizoids long, numerous. Leaves on the sterile plants and on the basal portion of the fertile plants secund on the antical side, oblique, closely imbricate, erecto-patent, base broad, antical basal portion slightly decurrent, postical non-decurrent, rounded, up to 1 mm. in diameter, entire, apex rounded, truncate or with a shallow notch. Leaves near the apex in the fertile plants longer, squarrose-spreading, saccate on the antical base, ampliate on the postical base. Upper cells 25–29  $\mu$ , basal cells 40–48  $\mu \times$  25–33  $\mu$ ; walls thin, trigones large. Andrœcia terminal or intercalary, spicate, bracts 6–8 pairs, antically saccate, directed towards the apex of the stem and closely appressed. Bracts more or less laciniate, often unequal; bracteoles laciniate. Perianth exserted, ovate, inflated, upper half plicate, mouth shortly lobed, lobes ciliate, capsule longly pedicelled, exserted, ovoid. Spores tetrahedral, dark brown, 12–15  $\mu$ , smooth. Elaters concolorous, 160–180  $\mu$ , rather closely bispiral, spirals thick, brown.

Plate XXII, figures 4–9.

Hab. On moist rocks.

Distrib. *Dalhousie*; Kumaon.

\* \* \* \*

### XVIII. SOLENOSTOMA 'Mitt.

*Solenostoma* Mitt. (1867); St., Sp. Hep., Vol. II, p. 46 (1901).

*Aplozia* Dum., Hep. Europ., p. 55 (1874).

*Haplozia* K. Müll., Rabh. Krypt. Fl. I, p. 535 (1909).

Plants small or medium, delicate or robust, cœspitose, green, reddish or brownish purple. Stem prostrate or ascending, seldom erect, simple or slightly branched, often with one, rarely two, sub-floral innovations. Rhizoids numerous, hyaline. Leaves alternate, succubous, obliquely or almost transversely inserted, more or less spreading, rounded, ovate or oblong. Amphigastria usually absent. Andrœcia terminal or intercalary, spicate or hypogynous; bracts saccate, otherwise like the leaves, 1–3-androus. Involucral

bracts in one to several pairs, like the leaves, free or more or less fused with the perianth at the base. Perianth clavate or cylindrical, upper portion with a few folds, mouth narrow and more or less tubular, crenulate. Capsule longly pedicellate, oval or sub-spherical, wall of two layers of cells, the outer with nodular thickenings, cells of the inner layer with semi-annular thickenings. Spores small, brown. Elaters short, attenuate, bispiral.

*Key to the species.*

- |   |   |  |    |                      |
|---|---|--|----|----------------------|
| 1 | { | Leaves large, perianth tubular .. ..       | .. | <i>S. breviflora</i> |
|   | { | Leaves not so large, perianth more or less |    |                      |
|   |   | pyriform .. ..                             | .. | 2                    |
| 2 | { | Leaves non-decurrent, close-packed ..      | .. | <i>S. crenulata</i>  |
|   | { | Leaves decurrent, not so close ..          | .. | 3                    |
| 3 | { | Leaves semi-amplexicaul, squarrose ..      | .. | <i>S. purpurata</i>  |
|   | { | Leaves not amplexicaul, patent ..          | .. | <i>S. lanceolata</i> |

**82. *Solenostoma lanceolata* (L.) St.**

*Solenostoma lanceolata* (L.) St., Sp. Hep., Vol. II, p. 60 (1901).

*Jungermannia lanceolata* L., Sp. pl., 1527.

*Jungermannia lanceolata* Schrad., Samml. Lief. 2, p. 4 (1797).

*Aplozia lanceolata* Dum., Hep. Eur., p. 59 (1874).

*Haplozia lanceolata* (Schrad.) Dum.; Müll. Rabh. Krypt. Fl. I, p. 572 (1906).

Diœcious, cœspitose, in reddish brown patches. Stem prostrate, up to 2 cm. long, simple or sparsely branched, with sub-floral innovations. Rhizoids in tufts, long, brownish. Leaves alternate, obliquely inserted, imbricate, patent, recurved, sub-orbicular or quadrate to oblong-ovate, up to 2 mm. long and 1.75 mm. broad, usually 1.5 mm.  $\times$  1.25 mm., antical base decurrent, margin entire, apex rounded or truncate. Upper cells 24–28  $\mu$ , basal cells 50–60  $\mu \times$  24–28  $\mu$ ; walls rather thin, trigones large and distinct at the base, small at the apex. Bracts like the leaves, larger. Perianth cylindrical-clavate, exserted, not fused with the bracts, suddenly contracted into a narrow crenate beak.

Plate XXIII, figures 1–3.

Hab. On moist rocks.

Distrib. *Alwas-Sitrundi* Road.

*Note*.—The plant is said to be monœcious but we have not seen any antheridia in our specimens. It is also said to bear gemmæ on the stem apex and the leaves but we have not seen any.

### 83. *Solenostoma crenulata* (Sm.) St.

*Jungermannia crenulata* Sm., Eng. Bot., pl. 1463 (1805).

*Solenostoma crenulata* St., Sp. Hep., Vol. II, p. 49 (1901).

*Nardia crenulata* Lindb., Bot. Notis., p. 167 (1872).

*Aplozia crenulata* Dum., Hep. Eur., p. 57 (1874).

*Haplozia crenulata* (Sm.) Dum., Müll. Rabh. Krypt. Fl. I, p. 538 (1906).

Dioecious, small, in dense and extended patches. Stem prostrate, about 10 mm. long, simple or sparsely branched, subfloral innovations present and often with many small-leaved branches in the same patch. Rhizoids long, hyaline, numerous, extending up to the apex of the stem. Leaves alternate, more or less imbricate, subsecund on the antical side, almost transversely inserted, erecto-patent to patent, concave above, orbicular, up to 0.75 mm.  $\times$  0.75 mm. (sometimes slightly broader than long), fixed by a narrow base, antical base slightly decurrent, entire, rounded. Cells 25–36  $\mu$ , polygonal or oblong, marginal cells forming a distinct border, walls rather thick, trigones absent or indistinct. Androecia terminal, bracts small, closely overlapping, up to 8 pairs. Involucral bracts like the leaves but larger and slightly fused with the perianth. Perianth pyriform,  $\frac{1}{3}$ – $\frac{1}{2}$  exserted beyond the bracts, upper contracted into a small mouth, 3-4-plicate, mouth denticulate.

Plate XXIII, figures 4-5.

Hab. On moist rocks.

Distrib. Kulu Valley, 8–11,000 ft.

*Note*.—In these specimens the marginal cells are about the same size as the inner cells, being sometimes slightly larger and at others slightly smaller. The outer walls of the marginal cells are in most cases thin, in other cases thick with very thick outer



angles. In this latter case the radial walls are usually quite thick and the trigones are distinct though small.

In the typical form of this species described by various writers the marginal cells are said to be larger than the inner cells but in var. *gracillima* in which the plants are brownish red and with numerous small-leaved branches the marginal cells are almost the same size as the inner cells.

#### 84. *Solenostoma breviflora* Sp. Nov.

Dioecious, in loose tufts of light green or dark brown colour, mixed with mosses. Stem prostrate or ascending, 1–3 cm. long, sparsely branched, lower portion leafless, sub-floral innovations present. Rhizoids hyaline or brownish, in tufts, extending to the apex of the stem. Leaves alternate, more or less imbricate, subsecund antically, erecto-patent to patent, but on smaller basal branches rather lax and almost horizontal, transversely inserted, suborbicular to ovate, up to 2 mm. in diameter, often less, antical base hardly decurrent, postical ampliate, margin entire, apex rounded, often retuse. Upper cells  $22\text{--}30\ \mu$ , basal cells  $70\text{--}125\ \mu \times 30\text{--}45\ \mu$ ; walls thick, trigones only slightly or not at all thickened. Bracts like the leaves but larger, not fused with the perianth, one of them folded over the perianth. Bracteole sometimes present, small and narrow, fused with the perianth. Perianth cylindrical to clavate, not exserted, subplicate in the upper part, often winged on the postical side, mouth irregularly toothed or crenulate.

Plate XXIII, figures 6–10.

Hab. On rocks.

Distrib. Simla, 6–7,000 ft.

*Note.*—In the brown specimens cell-walls are thickened and trigones are present.

This species resembles closely *S. sphærocarpa* (Hook.) St. [= *Aplozia sphærocarpa* (Hook.) Dum.]

#### 85. *Solenostoma purpurata* Mitt.

*Jungermannia purpurata* Mitt., Jour. Proc. Linn. Soc., Vol. V, p. 91 (1860).

*Solenostoma purpurata* Mitt.; St., Sp. Hep., Vol. II, p. 51 (1901).

Diœcious, in loose dark purple tufts. Stem up to 2 cm. long, simple, wiry, lower portion leafless, sub-floral innovations present. Rhizoids few, confined to the base. Leaves alternate, smaller and distant below, slightly overlapping and becoming larger above, obliquely inserted, patent, concave above, suborbicular, a little broader than long, up to 1.50 mm.  $\times$  1.25 mm., base cordate, longly decurrent on both sides, very much so on the postical side, margin entire, markedly revolute. Marginal and upper cells 10–15  $\mu$ , basal cells 27–47  $\mu \times$  15–22  $\mu$  (many smaller); walls thin, indistinct. Bracts larger than the leaves otherwise similar, slightly fused with the perianth. Bracteole when present small, adherent to one of the bracts. Perianth  $\frac{3}{4}$  exserted, clavate, subpubescent near the apex, mouth beaked, shortly lobed-denticulate. Spores 12–15  $\mu$ , purplish. Elaters concolorous, bispiral, spirals thick, broad, 80–130  $\mu$ .

Plate XXIV, figures 1–4.

Hab. Terrestrial.

Distrib. *Silrundi*, 10,000 ft.

*Note*.—The plant agrees very closely with the description given by Mitten though his description as usual is very brief. Stephani's amplified description of this species is, however, a little different. Mitten says that the leaves are orbicular while Stephani says cordiform, i.e. the apex distinctly narrowed from a broad base. In our specimens the leaves are distinctly orbicular. There is a little difference between the size of the cells also as given by Stephani but it is not very marked.

\* \* \* \* \*

## XIX. JUNGERMANNIA L. Ex. parte.

*Eucalyx* Breidl., Mitt. Nat. Ver. Steierm., p. 291 (1893); Mac. Stu. Hand. of Brit. Hep., p. 134 (1926).

Plants small or large, prostrate or erect, with numerous rhizoids, frequently stoloniferous, rhizoids generally purple, occasionally hyaline. Leaves entire. Amphigastria absent. Androecia long, spicate, bracts saccate at the base, squarrose-recurved above, di-androus. Involucral bracts larger, two to many pairs, coalesced with the perianth or free. Perianth more or less amplate,

upper half plicate, contracted, mouth lobed or setulose, rarely broadly open. Capsule globose or oval, cells of the inner wall with semi-annular bands. Spores small. Elaters small, attenuate, bispiral, ligulate.

*Key to the species.*

- |   |   |  |                        |
|---|---|--|------------------------|
| 1 | { | Leaves plano-distichous .. ..            | <i>J. humilis</i>      |
|   | { | Leaves patent to horizontal .. ..        | 2                      |
| 2 | { | Braets fused with the perianth .. ..     | <i>J. oblongifolia</i> |
|   | { | Braets not fused with the perianth .. .. | <i>J. viridis</i>      |

*Note.*—This genus is exceedingly like *Solenostoma*, but differs in the form of the perianth.

**86. *Jungermannia oblongifolia* Sp. Nov.**

Dioecious, small, in compact patches, mixed with other liverworts. Stem simple or sparsely branched, ascending, up to 15 mm. long. Rhizoids numerous, long, extending up to the apex of the stem, those near the apex hyaline. Leaves subsecund, alternate, imbricate, obliquely inserted, patent-divergent to horizontal, concave above near the base, usually decurved in the apical half, asymmetrical, oblong to oblong-ovate, up to 1.5 mm.  $\times$  1.00 mm., base broad, antical decurrent, postical not so, margin entire, apex rounded, sometimes with a slight notch. Upper cells 25–32  $\mu$ , basal 43–60  $\mu \times$  25–30  $\mu$ , walls thin, trigones distinct. Androecia intercalary, bracts 4–6 pairs, saccate at the antical base otherwise similar to the leaves. Braets slightly larger than the leaves, otherwise similar. Perianth lanceolate, exserted, lower  $\frac{1}{3}$  adnate to the bracts, 3-4-pluri-plicate to the base, mouth narrow, bilobed, lobes again lobulate-toothed.

Plate XXIV, figures 5–10.

Hab. On moist soil and rocks.

Distrib. *Silrundi*, 10,000 ft.

**87. *Jungermannia viridis* Sp. Nov.**

Plants small, in loose green patches. Stem about 1 cm. long, flaccid, prostrate, simple or sparsely branched. Rhizoids numerous and purple at the base, hyaline above. Leaves lax or slightly imbricate, obliquely inserted, antical base slightly

decurrent, postical not so, patent to almost horizontal, suborbicular to oblong-ovate, up to 1.5 mm.  $\times$  1.0 mm., margin entire, apex rounded, decurved. Upper cells 20-32  $\mu$ , basal 70-100  $\mu \times$  25-35  $\mu$ , many smaller; walls thin, trigones absent in the upper part and distinct in the lower part. Androecia intercalary, bracts 4-6 pairs, saccate at the base. Involucral bracts like the leaves but much longer, erect in the lower part, spreading above, enclosing the lower  $\frac{1}{2}$  of the perianth but not fused with it. Perianth exserted, lanceolate, triplicate, mouth narrow.

Plate XXV, figures 1-4.

Hab. On moist soil.

Distrib. Dehra Dun, 2,000 ft.

*Note.*—The plant is very similar to *Jungermannia oblongifolia* but it is more lax in habit and is especially distinguished by the free perianth which is merely enclosed by the bracts at the base whereas in the other species it is fused with the bracts in the lower part.

#### 88. *Jungermannia humilis* Sp. Nov.

Sterile, small, in dense green patches. Stem up to 2 cm. long, slender, sparsely branched. Rhizoids scanty, long, hyaline. Leaves imbricate, plano-distichous, almost longitudinally inserted by a long base, antical decurrent, postical not so, semi-circular, up to 1.25 mm.  $\times$  1.0 mm., margin entire, apex rounded. Upper cells 30-40  $\mu$ , basal 60-80  $\mu \times$  40-60  $\mu$ , walls thin, trigones absent.

Plate XXV, figures 5-7.

Hab. On soil on the sides of drains.

Distrib. Lahore, Amritsar.

*Note.*—This species comes to the lowest altitude and is the only foliose species occurring in the plains.

The following species of *Jungermannia* have been described by Stephani but have not been seen by us.

#### 89. *Jungermannia Duthiana* St.

*Jungermannia Duthiana* St., Sp. Hep., Vol.-II, p. 71 (1901).

Monœcious, hypogynous, medium, yellowish green, densely caespitose, on bark. Stem up to 10 mm. long, erect, slightly

branched, sub-floral innovations rare. Leaves remote, strongly concave, ascending, suborbicular. Marginal cells  $18\ \mu$ , subapical cells  $27\ \mu$ , median cells  $30\ \mu \times 27\ \mu$ , basal  $54\ \mu \times 27\ \mu$ ; trigones small in the upper portion, absent from the basal portion. Perianth large, exserted, clavate, upper half 3-4-plicate, mouth small, contracted, dentate. Bracts two, fused with the base of the perianth, strongly concave and slightly spreading. Male bracts two or three pairs, similarly concave and slightly spreading, mon-androus, antheridia globose, pedicel thick. Pedicel of the capsule 12 mm. long and strong, capsule oval. Spores  $22\ \mu$ , rust-coloured. Elaters concolorous, strongly attenuated, bispiral, spirals ligulate, densely twisted.

Hab. Kashmir (Duthie).

#### 90. *Jungermannia tenerrima* St.

*Jungermannia tenerrima* St., Sp. Hep., Vol. VI, p. 94 (1917).

Diœcious, medium, pale green, flaccid, terrestrial, dense depresso-cæspitose. Stem up to 2 cm. long, branched, branches long, stoloniferous, few. Leaves contiguous, more or less spreading, thin, plane, ovate, 2.75 mm. long and 2.5 mm. broad in the middle, apex obtuse, inserted by a broad base, entire. Upper cells  $54\ \mu \times 36\ \mu$ , basal  $90\ \mu \times 45\ \mu$ , trigones absent. Amphigastria absent. Bracts appressed, free,  $\frac{1}{2}$  shorter than the perianth, ovate, 3.5 mm.  $\times$  2.75 mm., apex crisp, rest entire, bracteoles absent. Andrœcia not seen. Perianth large, cylindrical, 5 mm. long and 2 mm. broad, apex slightly narrow, truncate, pluriplicate, entire.

Hab. Himalaya, Mussoorie (Gollan).

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#### XX. SOUTHBYA- Spruce. --

*Southbya* Spruce, Ann. Mag. Nat. Hist. Ser. II, Vol. III, p. 501 (1849).

Plants small, cæspitose or among mosses. Stems decumbent, simple or slightly branched with numerous long rhizoids. Leaves opposite, obliquely nearly transversely inserted, succubous, closely imbricate, contiguous or slightly connate at the antical base,

roundish to oval, entire. Amphigastria absent. Involucral bracts erect, highly connate, free margins erose or dentate. Bracteole ovate-lanceolate, fused with the bracts or nil. Perianth shorter than the bracts, concrete with them in the lower part, the mouth wide, lobed or dentate. Capsule oval, globose, 4-valved to the base, valves with semi-annular bands.

This genus even when sterile can be easily distinguished from *Solenostoma* and *Jungermannia* by its opposite leaves.

*Southbya Gollani* St. has been described by Stephani from Mussoorie but has not been seen by us.

#### 91. *Southbya Gollani* St.

*Southbya Gollani* St., Sp. Hep., Vol. III, p. 37 (1906).

Diœcious, small, delicate and fragile, brown, dense caespitose or mixed with mosses. Stem up to 10 mm. long, prostrate, simple, with sub-floral innovations. Rhizoids from the under-surface. Leaves small, opposite, erecto-connivent, antical base contiguous or slightly connate, rest subrotund, entire, thin. Upper cells 18  $\mu$ , basal twice as long, walls thin. Bracts gradually larger, uppermost fused together forming a tube, margins crisp, entire. Bracteoles rudimentary or absent. Perianth? Capsule longly pedicelled, globose, to about the base dehiscing into four valves, valves with semi-annular bands.

Hab. Himalaya, Mussoorie, Naa Tibai. 10,000 ft.

### SUBORDER Anacrogynæ.

Gametophyte generally a thallus, sometimes with stem and leaves. Sex organs on the dorsal side. Archegonia in groups.

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### FAMILY IX. CALOBRYACEÆ.

Stems erect, arising from a fleshy rhizome-like basal portion. Leaves arranged radially and more or less regularly in three rows, simple. Rhizoids absent. Female inflorescence on the upper part of the stem, without any involucre. Calyptra large, cylindrical. Capsule cylindrical, the wall of one layer of cells except at the apex, with longitudinal annular thickenings. Elaters bispiral.

Not represented by any species in this area.

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### FAMILY X. CODONIACEÆ.

Thallose, foliose or forms intermediate between them. In the foliose forms leaves in two rows, parallel to the stem or obliquely inserted and succubous, simple. Rhizoids always present. Male and female inflorescences scattered on the dorsal side or in groups. Archegonial cluster surrounded by an involucre. Capsule usually with a long seta, globose (oval in *Blasia*), dehiscing to the base by four valves or irregularly; the wall usually of two layers of cells (four in *Blasia*, *Treubia*), well-developed fibrous bands being usually present on either the outer or the inner cells or on both. Elaters adherent to the base or apex of the capsule or partly free, more rarely altogether free, 2-4-spiral.

#### Key to the genera.

- |   |   |  |                        |
|---|---|--|------------------------|
| 1 | { | With leaf-like lobes .. ..               | 2                      |
|   | { | Wholly thallose .. ..                    | 3                      |
| 2 | { | <i>Nostoc</i> colonies in the thallus .. | .. <i>Blasia</i>       |
|   | { | No <i>Nostoc</i> colonies .. ..          | .. <i>Fossombronia</i> |

3	{ Dorsal lamellæ present ..	..	<i>Petalophyllum</i>
	{ No dorsal lamellæ ..	..	4
4	{ Apical tubers present ..	..	<i>Sewardiella</i>
	{ No apical tubers ..	..	5
5	{ Antheridia in pits, no bracts ..	..	<i>Pellia</i>
	{ Antheridia superficial, bracts present ..	..	<i>Calycularia</i>

\* \* \* \* \*

## XXI. FOSSOMBRONIA Raddi.

*Fossombronia* Raddi, in Atti Soc. Ital. Mod. 18 (1818).

Stem creeping, simple or dichotomously branched, flattened above and strongly arched below, with long, mostly violet-coloured smooth rhizoids. Leaves green, in two rows, succubous, obliquely inserted and decurrent, generally broader than long, with irregularly sinuate and usually lobed margin, base more than one cell thick, rest 1-layered, cells large, thin-walled. Antheridia orange yellow, accompanied by bracts, on the dorsal surface of the stem near the insertion of the leaves. Archegonia singly on the dorsal surface of the stem at the bases of the leaves. Each on fertilisation becoming enclosed in a perianth. Perianth with a wide lobed mouth and narrow base, often longitudinally plicate, frequently incised to the base. Calyptra pyriform, thick at the base. Capsule shortly pedicellate, globose, dehiscing irregularly or imperfectly by four-valves. Wall of two layers of cells, the inner layer with frequently incomplete bands. Spores large, rounded, tetrahedral. Elaters short, bi- or tri-spiral.

### 92. *Fossombronia himalayensis* Kashyap.

*Fossombronia himalayensis* Kashyap, New Phyt., Vol. XIV, p. 4 (1915).

*Fossombronia Levieri* St., Sp. Hep., Vol. VI, p. 74 (1917).

Monœcious or dicecious. Plants caespitose among grass or moss or singly on moist rocks, small and compact in former places but open and longer in latter places, two or three times branched, branches up to 6 mm. long. Rhizoids usually violet, sometimes hyaline. Leaves oblong, wavy, ascending, overlapping to about



$\frac{1}{3}$  of the length, outer margin irregularly and indistinctly toothed. Perianth with wavy margin, sometimes split to the base along one side. Seta up to 5 mm. long, often very short; capsule usually exserted. Cells of the outer layer of the capsule wall with thin walls, those of the inner layer with U-shaped bands on the inner and radial walls near the apex but only simple bands on radial walls at other places. Dehiscence by separation of the apical portion. Spores brown with furcate high lamellæ, sometimes forming a few reticulations, 40–50  $\mu$  in diameter. Elaters brown, laxly bi- or tri-spiral, 100–140  $\mu$  long.

Plate XXVI, figures 11–15.

Hab. Moist rocks or among grass and moss.

Distrib. Common. Outer Himalayas, Ravi valley; *Simla*, etc.; Kumaon, *Mussoorie*, etc. 5,000–7,000 ft.; *Lahore*, rare; *Jawala-mukhi* (Devi Dyal); South India, Nilgiris (Rangachariar); Bombay, *Panchgani* (Blatter).

Note.—Towards the end of the season the apex of the plants ceases to form the leaves, bends downwards and becomes thickened. These apical tubers are thus borne on cylindrical stalks and remain buried in the ground during winter. They grow out into new plants next spring.

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## XXII. SEWARDIELLA Kashyap.

*Sewardiella* Kashyap, New Phyt., Vol. XIV, p. 5 (1915).

Diœcious. Plants thallose, simple or forked, occurring in thick patches on rocks or singly among grass and moss in shady places. Thallus winged, wings attenuated, directed upwards. Dorsal surface concave. Midrib thick, projecting ventrally, flat above and rounded below. Ventral surface usually with minute red scales in two rows. Wings many-layered at the base, gradually becoming thin and 1-layered throughout the greater portion, ascending, margin wavy. Male and female plants similar. Antheridia in a cluster on the dorsal side of the midrib mingled with a few bracts. Archegonia in a cluster on the dorsal side. Perianth

bell-shaped, margin lacerated into numerous processes, often split at one or more places up to the base, many-layered at the base, 1-layered above. Calyptra thin, 1-layered. Sporogonia one or more in each perianth; foot small; capsule included or slightly exserted. Capsule wall 1-3-layered; inner layer with thick bands. Spores reticulate-lamellate. Elaters bi- or tri-spiral; no fixed elater-like cells anywhere in the capsule.

93. *Sewardiella tuberifera* Kashyap.

*Sewardiella tuberifera* Kashyap, New Phyt., Vol. XIV, p. 5 (1915).

Diœcious. Thallus up to 10 mm. long and 12 mm. broad, often once forked, arising from a thick base and ending in a wingless stalked tuber at the apex, the apical wingless portion often forked, midrib mycorrhizal, thick, projecting ventrally, rounded below. Ventral surface usually with minute red scales in two rows. Wings often unequal, many-layered at the base, gradually becoming thin, one-layered throughout the greater portion, ascending, margin wavy; upper surface of the thallus concave. Antheridia on the midrib, each antheridium globular, on a short stalk; bracts few, scattered between the antheridia. Perianth bell-shaped; margin lacerated into numerous narrow processes; calyptra thin, 1-layered. Sporogonia 1-3, sometimes more, in each perianth; foot small, seta up to 1.25 mm. long, capsule 1-1.3 mm. in diameter, included or slightly exserted. Capsule wall 2-3-layered; the cells of the outer layer usually thin-walled, sometimes with thick bands on the radial walls; cells of the inner layer with U-shaped bands on inner and radial walls or only simple bands on the radial walls. Spores reticulate-lamellate, less than four reticulations in the diameter, 40  $\mu$ . Elaters bi- or tri-spiral, 300-400  $\mu$ ; no fixed elaters at the base or elsewhere.

Plate XXVI, figures 6-10.

Hab. In large patches on moist rocks, occasionally singly among moss or grass.

Distrib. Common at 5,000 to 7,000 ft., *Mussorie*, *Simla*, etc.

Note.—Towards the end of the season the plant forms apical tubers like *Fossombronina himalayensis*. The thick tubers are

borne on cylindrical stalks, are covered by small red scales and remain buried in the soil during winter. When the tubers germinate next year the scales are carried on the under-surface of the plants but are naturally restricted mostly to the posterior part of the plant. The tuber-bearing portion often forks and sometimes the whole plant is forked, each branch bearing a tuber at the apex.

The plant is closely allied to *Fossombronia himalayensis* not only as regards tuber-forming habit but in the position of the sex organs, the perianth and the structure of the sporogonium. As a matter of fact, the only difference between the two genera is that, whereas, in *Fossombronia* the wing is divided into lobes (leaves), in *Sewardiella* it is entire. *Sewardiella* may be said to be a condensed *Fossombronia*. The plant may well be put in the genus *Fossombronia* if the same procedure is followed in the other *Anacrogynous Jungermanniales*, and the difference between an entire and a lobed wing (leafy stem) is not considered to amount to a generic difference.

The plant can be easily recognised by its midrib raised up in the middle and bent down both anteriorly and posteriorly, and ascending wings. From the apical tuber, which lies buried underground, the plant on germination begins to grow upwards, then grows horizontally for a short distance and ultimately bends down to form a new tuber. The midrib in this way forms a characteristic bend with the concavity downwards. Several such bends may be met with in the same plant behind one another indicating several years' growth, but the wing, naturally, disappears in the older plants.

In the young condition the plant is exceedingly like the tuberous prothallus of *Gymnogramme leptophylla*, a fern, which is sometimes met with in the localities where this plant grows.

The perianth arises in the form of several bracts, which do not grow simultaneously. Gradually the bracts fuse and all of them are then carried upwards by basal growth. Sometimes fusion cannot take place at one or two places, the bracts being at a distance from each other. In such cases the perianth shows one or two splits extending to the base. As the bracts do not arise in a regular ring but some towards the outside and others towards the centre nearer the archegonia we find that in the ripe perianth

these may be fused to both the inner and the outer surface of the perianth. Sometimes the number of these bracts is so great that the perianth has the appearance of a double flower.

The morphology of the involucre and the perianth in the *Codoniaceæ* requires further investigation. As pointed out above, in the genus *Sewardiella* in the young condition, the archegonia are surrounded by a number of bracts, and these later on, by basal zonal growth, are carried upwards and a more or less bell-shaped structure is produced which has got these bracts on the margin and often on the inner and outer surface also. The whole structure may as well be called an involucre.

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### XXIII. PETALOPHYLLUM Gottsche.

*Petalophyllum* Gottsche in Lehm. Pug. Pl. VIII, p. 29 (1844).

Plants small and slender with a short basal cylindrical stalk-like portion and a fan-like expansion, simple or furcate, with parallel erect lamellæ on the dorsal surface. Antheridia scattered on the dorsal surface, spherical, with a pedicel, accompanied by scales. Archegonia in groups on the dorsal surface, surrounded by scales and enclosed at maturity by the tubular perianth. Calyptra free, large. Capsule rather shortly pedicellate, spherical, dehiscing irregularly. Wall of three or four layers of cells, the inner with incomplete annular bands. Spores reticulate-lamellate. Elaters long, more or less attenuate, 2-3-spiral.

#### 94. *Petalophyllum indicum* Kashyap.

*Petalophyllum indicum* Kashyap, Jour. Ind. Bot. Soc., Vol. VII, p. 14 (1928).

Dioecious. Plants simple or furcate, growing singly or in patches of three or four, up to 12 mm. long and 7 mm. broad. Basal portion cylindrical and wingless. Wing many-layered at the base, gradually becoming one-layered, wavy along the margin. Lamellæ one-cell thick and 15-24 cells high, running outwards and forwards from the midrib, not always parallel. Antheridia in groups behind the apex, protected by scattered scales. Arche-

gonia in groups of 4-7 on the midrib, protected by a bell-shaped perianth with a lacerated margin, often with two or three splits along the whole length. Sporogonia 1-4, usually one, in each perianth. Seta usually 10-20 mm. long, sometimes very short, occasionally up to 25 mm. Capsule 2 mm. in diameter, spherical, dark brown. Capsule wall usually 3-layered; cells of the outer layer thin-walled, sometimes with thick radial walls; those of the inner layers with thick annular or sometimes semi-annular bands. Spores dark brown, about  $40\ \mu$  in diameter, spherical, with a membranous wavy margin, reticulate-lamellate, 3-4 reticulations in the diameter, reticulations pentagonal or hexagonal,  $8-10\ \mu$ , marginal wing  $14-17\ \mu$ . Elaters trispiral, lightly coloured, spirals very distinct, brown and lax,  $280-400\ \mu$  long,  $8-10\ \mu$  broad, simple or occasionally branched, attenuated towards both ends. A few elaters are short and about  $16\ \mu$  broad.

Plate XXVI, figures 1-5.

Hab. Moist places.

Distrib. Lahore, Ravi bank; Bank of the Beas.

Note.—At the end of the season the apex becomes thickened forming a tuber and becomes buried underground. The dorsal vertical lamellæ easily distinguish this plant from other liverworts.

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#### XXIV. BLASIA L.

*Blasia* L., Sp. Pl., p. 1138 (1753).

Thallus several times dichotomously branched, with a broad midrib passing into 1-layered lobes (leaves). Under-leaves in one row on each side of the midrib. Leaf-auricles containing *Nostoc* colonies present at the base of the lobes usually in pairs. Male plants smaller, antheridia oval, with a short pedicel, immersed singly in small chambers. Archegonia in a cluster, at first naked, the fertilised one becoming enclosed by a fusiform thick involucre with a constricted mamillate apex. Calyptra free, thin and membranous. Capsule rather longly pedicellate, oval, with a collar at the base. Dehiscence by 4, rarely 5-6 valves. Capsules wall of 3-4 layers

of cells, those of the outer layer with thick radial walls, those of the inner layers smaller and tender, without bands and soon becoming disorganised. Elaters bispiral, spirals often splitting. A few rudimentary elaters fixed at the base of the capsule. Gemmæ of two kinds.

#### 95. *Blasia pusilla* L.

*Blasia pusilla* L., Sp. Pl., p. 1138 (1753).

Dioecious. Plants rather fleshy, dichotomously branched, lobed, lobes (leaves) rather shallow, not extending to the midrib, very leaf-like at the apex. Thallus up to 30 mm. long and up to 5 mm. broad. Midrib broad, projecting ventrally, gradually passing into the wings, about 10 cells thick in the middle. Upper and lower epidermal cells small, middle ones large. Under-leaves in two rows, one on each side of the midrib, distant, small, hyaline, ovate to subrotund, irregularly toothed, peltate. *Nostoc* auricles usually two at the base of each lobe. *Nostoc* colonies rounded or oval, seen from the dorsal side through the thallus, appearing as if embedded in the thallus. Star-shaped gemmæ generally present behind the apex, easily detached and scattered. Flask-shaped gemmæ receptacles rare. Male plants smaller, antheridia few, oval. Pedicel of the capsule 2 cm. long. Spores 33–43  $\mu$ , rounded, yellowish brown, granular. Elaters paler in colour.

Plate XXVII, figures 1–4.

Hab. Moist rocks.

Distrib. Kulu (6,000 ft.), Nagar; Kumāon; Garhwal, Gangotri Road.

*Note.*—The sterile plants resemble *Anthoceros* superficially on account of the *Nostoc* colonies. They can be easily distinguished by the star-shaped gemmæ which are almost always present on the dorsal surface just behind the apex.

The plant is intermediate between the thallose and the foliose forms. The lobes in the posterior part are quite shallow, but at the apex they are very leaf-like. They are regarded as lobes or leaves variously by different writers. In addition to these lobes the plant has other appendages on both the ventral and dorsal surfaces. On the ventral surface are the under-leaves and *Nostoc* auricles. On

the dorsal surface are found two kinds of gemmæ. Just behind the apex naked star-shaped gemmæ are met with in almost all plants. These scale-like gemmæ are loosely attached singly to the dorsal surface behind the apex and are fixed at the base, unlike the amphigastria which they resemble in shape but which are peltate. The gemmæ begin to grow while still attached to the plant and are usually detached in the form of a tuft. They are easily detached and are seen scattered on the dorsal surface. Other gemmæ are met with in flask-like cavities on the dorsal side. Sometimes archegonia occur in these receptacles along with the gemmæ.

We have so far come across no ripe sporogonia and the description of the sporogonium is after Macvicar and Stephani.

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## XXV. PELLIA Raddi.

*Pellia* Raddi, Mem. Soc. Ital. Mod. 18, p. 49 (1820).

Thallus thin, prostrate, dichotomously branched, with a broad midrib, slightly projecting below, gradually passing into the wings; wing many-layered towards the midrib, becoming 1-layered towards the margins. Internal cells wider than the epidermal cells. Scales absent; club-shaped mucilage hairs present at the apex. Antheridia globular, shortly stalked, immersed singly in the cavities on the dorsal side of the midrib in two to several rows. Archegonia on the dorsal surface of the thallus in a pit surrounded by a complete or incomplete (open in front) tubular involucre, capsule with a long seta, globular, wall two or more cells thick, dehiscing by four valves up to the base. Spores large, germinating within the capsule. Elaters 2- or 3-spiral, many fixed to the base of the capsule.

*Note.*—All the three species of the genus are said to occur in the Himalayas. Unfortunately fertile plants with ripe sporogonia are rarely met with. *P. calycina* as described here is exceedingly common throughout the Western and the Kumaon Himalayas from 5,000–8,000 feet. *Pellia epiphylla* is exceedingly common in Sikkim and the Eastern Himalayas generally, being very abundant round about Darjeeling on the road to Tiger Hill,

etc. What looks like *P. epiphylla* has been met with occasionally in the Western Himalayas, but we have not come across specimens, which could be certainly referred to *P. Neesiana*.

Stephani does not mention the presence or absence of fibrous bands as a distinguishing feature of the species. All the specimens described here under *Pellia calycina* are without such fibres, though the involucre in these forms is more like that described by others for *P. Neesiana*.

*Key to the species (after Macvicar).*

- |   |   |   |                     |
|---|---|---|---------------------|
| 1 | { | Thallus without fibrous bands on the cells  |                     |
|   |   | as seen in cross section of the thallus ..  | <i>P. calycina</i>  |
| 2 | { | Thallus with brown bands, calyptra exerted, |                     |
|   |   | inner wall of the capsule with bands ..     | 2                   |
| 2 | { | Monœcious; involucre hood-like posteriorly, |                     |
|   |   | wanting in front ..                         | <i>P. epiphylla</i> |
|   | { | Dioecious; involucre complete, tubular ..   | <i>P. Neesiana</i>  |

**96. *Pellia calycina* (Tayl.) Nees.**

*Pellia calycina* Nees, Hep. Eur. III, p. 386 (1838).

*Pellia Fabbroniana* Raddi, Mem. Soc. Ital. Scient. Mod. 18, p. 49 (1818).

Dioecious. Plants green, growing among moss and grass, or in dense patches of overlapping individuals under flowing water, dichotomously or more or less pinnately divided, lobes quadrate to oblong-linear, about 5 mm. broad, often with a dark streak along the mid-dorsal line, margin undulate, apex slightly notched. Midrib conspicuous, slightly projecting ventrally, gradually passing into the many-celled lamina, which becomes one-layered towards the margin, one-celled portion from a few to 15 cells broad, greatest thickness in the middle about 10 cells, no thickened bands on the cells. Antheridia conspicuous, in two or three rows on the dorsal side of the midrib. Archegonia in a cluster. Involucre tubular, directed forwards, posterior wall long, anterior short, mouth shortly irregularly dentate. Calyptra included. Seta long, pellucid. Outer layer of the capsule wall with nodular thickenings at the angles,





innermost layer without thickening bands. Spores 56-77  $\mu$  in diameter. Elaters vermiform, 10-12  $\mu$  broad, 3-4-spiral. Elater-bearers very long and slender, bispiral.

Plate XXVII, figures 5-6.

Hab. On moist soil among moss and grass, or actually under flowing water.

Distrib. Exceedingly common in the Kumaon and the Western Himalayas, becoming less frequent to the west up to Kashmir, 5,000-8,000 ft., *Mussoorie*; Kulu; *Simla*; *Dalhousie*; Pangi; *Murree*; Jammu, *Patni Pass*; *Verinag*; Kaghan Valley (N.A. Qizilbash); Poonch (R. R. Stewart); etc.

The description of spores and elaters given above is after Macvicar: Student's Handbook of British Hepatics, p. 75 (1926).

*Note*.—The plant forms large patches of overlapping individuals under flowing water, usually accompanied by *Dumortiera hirsuta* and often by *Conocephalum conicum*. It can easily be recognised from the former by its smaller size and lighter colour and from the latter by the absence of reticulations, pores and scales. It varies greatly in length, breadth and thickness of the lobes. In very moist and shady places the lobes are long, narrow and thin; in other places they are broader and thicker, with a conspicuous dark mid-dorsal streak. During the growing season the plants form a very characteristic tuft of small lobes at the apex owing to the rapid and repeated dichotomy.

#### 97. *Pellia epiphylla* (L.) Lindb.

*Jungermannia epiphylla* L., Sp. Pl. 1602.

*Pellia epiphylla* Lindb., Hep. in Hib., p. 534 (1874).

Monœcious, in flat dark green patches. Thallus narrow at the base, oblong or obcordate, up to 4 cm. long and about 1 cm. broad, entire or slightly undulate, midrib in section about 12 cells thick, cells with thickening bands. Involucre reduced to a pouch open in front, lobed at the free margin. Antheridia on the dorsal side along the middle in two or three rows behind the archegonial cluster. Calyptra exserted, tubular. Pedicel of the capsule

hyaline, long. Capsule globose, wall of two or three layers of cells, cells of the inner layer with semi-annular thickening bands and those of the outer layer with nodulose thickenings. Spores 80-100  $\mu$  in diameter, oblong-oval, muriculate. Elaters very long and thin, 8  $\mu$  broad, bispiral, elater-bearers thick, 3-4-spiral.

Plate XXVII, figures 7-8.

Hab. On moist rocks, etc.

Distrib. Common in Sikkim Himalayas, near about Darjeeling ; occasionally Western Himalayas.

Note.—The description of the capsule, spores and elaters is after Macvicar : Student's Handbook of British Hepatics, p. 72 (1926).

#### 98. *Pellia Neesiana* (Gottsche) Limpr.

*Pellia epiphylla* forma *Neesiana* Gottsche in Hedwigia, p. 69 (1867).

*Pellia Neesiana* Limpr., Krypt. Fl. Schles., p. 329 (1876).

Dioecious. In less extended patches than *P. epiphylla*, nearly always tinged with dark red, especially on the midrib, translucent towards the margin. Thallus rather narrower, more undulate and of more equal width, less expanded and usually less lobed at the apex ; in section about 12 cells thick in the middle with interlacing thickened bands. Involucre forming a short complete cylinder, or occasionally split on the antical side, irregularly crenate-lobulate at the mouth. Calyptra more or less exserted, seldom included, cylindrical with expanded apex, roughened with 2-celled scattered hairs. Capsule, spores and elaters as in *P. epiphylla*. Male plants generally growing with the female.

Plate XXVII, figures 9-10.

The above description is after Macvicar : Student's Handbook of British Hepatics, p. 73 (1926).

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### XXVI. CALYCULARIA Mitt.

*Calycularia* Mitt., Trans. Linn. Soc., Vol. V, p. 122 (1860).

Dioecious. Plants large or medium, gregarious, prostrate, light or deep green. Thallus dichotomous or innovating from the

apex, rarely so from the ventral surface, wings ascending, canaliculate; midrib rather broad, gradually passing into the wings. Wings gradually attenuated from a thick base and one cell thick towards the margins. Amphigastria always present, aggregated towards the apex of the lobes, lanceolate or subulate. Androecia on the dorsal side of the midrib, bracts more or less aggregated, each with one antheridium, erect, hood-like, apex lacerated. Archegonia aggregated towards the apex on the dorsal side. Bracts long, lanceolate, strongly lacinate or distantly spinous, united at the base into a ring. Perianth large, broad at the base, infundibuliform, campanulate or inflated-cylindrical, often with longitudinal folds; opening broad, spinous or lacerated. Calyptra large, base more or less thick. Capsule on a short pedicel, broadly oval, wall many-layered, cells of the external layer small, brown and equally thickened, cells of the inner layers delicate. Dehiscence by 4-7 valves. Spores small, papillate or echinate. Elaters short, fusiform, bispiral.

*Key to the species.*

Plants long, in tufts .. ..	.. <i>C. crispula</i>
Plants short, compact and solitary	.. <i>C. compacta</i>

99. *Calycularia crispula* Mitt.

*Calycularia crispula* Mitt., Trans. Linn. Soc., Vol. V, p. 122 (1860).

Dicecious. Plants large, strong, growing in tufts with mosses, pale green, simple or branched, ventral shoots present, up to 20 mm. long and 4 mm. broad, lobes broadly ligulate, margins crisped. Midrib conspicuous from above, 15 cells thick in the middle, broad, projecting ventrally and gradually passing into the wings, wings about half the width of the frond, flat. Amphigastria linear or linear-lanceolate, ending in a few-celled filaments, with one- or more-celled filamentous projections ending in rounded mucilaginous cells arising from the margin. Male plants smaller, androecia dorsal and often covering the whole of the midrib, in several rows. Antheridia short stalked, globular, in the axils of lacinated scales which are often more or less confluent. Archegonia in

a cluster on the dorsal side; each cluster surrounded by a number of involueral scales both at the back and on the sides but not in front, the involueral ring in front being completed by the upturned amphigastria. Perianth large, infundibuliform, lower portion entire, thick, upper lacerated, thin. Calyptra delicate. Capsule with a thick short seta, subglobose, spores 45–65  $\mu$ , purple brown, long echinate, bristles long, cylindrical, apex truncate. Elaters up to 350  $\mu$ , bispiral, or shorter (about 240  $\mu$ ) and thicker, some elaters branched.

Plate XXVIII, figures 1–6.

Hab. Mixed with mosses.

Distrib. Garhwal, *Mussoorie*, *Gaurikund*; Kumaon, *Gangoli-hat*; *Dalhousie-Khajiar* Road, about 7,000 ft.; *Darjeeling* very common on the road from Ghoom to Tiger Hill. The *Mussoorie* specimens were found by Mr. P. N. Mehra on the trunk of a tree.

*Note.*—In the young condition the archegonia are surrounded by scales on three sides, i.e. posteriorly and laterally, being protected in front by the upturned amphigastria. In many cases the posterior bracts are in several rows and extending for a considerable distance behind the receptacle.

The perianth arises in the form of several bracts which do not grow simultaneously. Gradually these bracts fuse and all of them are carried upwards by basal growth. Moreover, in many cases there are no bracts outside the perianth which make one think that the involucre is absent. The proper thing would be to say that the fusion has effected all the bracts so that no bracts are left free. Thus there is no hard and fast line between the involucre and the so-called perianth, and the perianth is the result of the fusion of all or most of the involueral bracts which are carried up by basal growth.

The following few cases are of special interest in this respect:—

1. In one case there were two bracts attached to the lateral surface of the mature perianth, one in front of it and two or three bracts absolutely free just behind the perianth.

2. In another mature perianth two sporogonia of different

ages were seen. Inside this perianth there were four free bracts quite separate from the perianth and one of them was quite large and actually separated the two sporogonia.

3. In another case behind a mature perianth were six scattered bracts and inside the perianth were found three bracts two of which arose from the base of the perianth and were not attached to it and the third one arose from the inner surface of the perianth and was attached to it. (Compare with the development of the perianth in *Sewardiella*.)

100. *Calycularia compacta* Kashyap Sp. Nov.

Dioecious. Plants small, dark green, occurring singly among moss and grass, slightly branched, with ventral shoots, 12 mm. long and up to 6 mm. broad. Rhizoids from the ventral surface of the midrib, numerous, simple, yellowish. Midrib conspicuous as seen from above, projecting below, up to 16 cells thick; wings thin, crisped, occasionally frenate, ascending, one cell thick throughout their greater portion. Amphigastria long linear, bent towards the dorsal side at the apex or merely filamentous, of a few cells each (6-10 cells). Bracts on the male plants many, laciniate, with long, linear or filamentous processes. Antheridia aggregated along the midrib throughout the length of the plant, globular, shortly stalked, accompanied by bracts. Bracts on female plants more or less ovate, laciniate or occasionally simply acuminate. Perianth erect, 1-2 mm. long, thick at the base, narrow below, broad above, thin, plicate, mouth shortly lobed, lobes irregularly spinous, denticulate. Rest not seen.

Plate XXVIII, figures 7-9.

Hab. On moist earth among moss and grass, mixed with *Aneura indica*.

Distrib. Lahul, *Kyelang*, 11,000 ft.

*Note*.—A small, delicate and very compact plant with very closely crisped margins. Older parts of the midrib mycorrhizal.

Possibly a compact form of *C. crispula* adapted to the dry climate of Lahul. In the present species the plants occur singly and not in tufts as in *C. crispula*. The plant grows up from a

cylindrical basal portion, then becomes horizontal, and at the end of the season bends down again.

#### FAMILY XI. BLYTTIACEÆ.

Thallus with a distinct and usually sharply defined midrib, male and female inflorescence on the dorsal surface of the thallus, not on special branches, the archegonia in groups. Involucres double or single. Capsule generally cylindrical, usually dehiscing incompletely by 2-4 valves, the inner wall without semi-annular thickenings.

Not represented by any species in this area.

#### FAMILY XII. ANEURACEÆ.

Thallus fleshy or membranous, in *Metzgeria* with a sharply defined midrib and a lamina composed of one layer of cells. Male and female inflorescences on short branches. Capsule oval or cylindrical, 4-valved, composed usually of two layers of cells, of which the inner possesses more or less distinct semi-annular bands. Elaters either free and tapering towards each end with one broad spiral band, or fixed, short and obtuse with an indistinct spiral band and persistent as erect tufts at the apex of the valves.

##### *Key to the genera.*

Thallus gradually thinning towards the margins .. *Aneura*  
Sharply defined midrib and one-layered wings .. *Metzgeria*

\* \* \* \* \*

#### XXVII. ANEURA Dum.

*Aneura* Dum., Comm. Bot., p. 115 (1822).

*Riccardia* S. F. Gray, Nat. Arr. Brit. Pl. 1, p. 683 (1821).

Thallus fleshy, often pinnately branched, with usually a broad midrib. Epidermal cells usually smaller than the inner cells. Sex organs on short lateral branches. Male branches with

a more or less circular outline, distinct, margin more or less papillate; antheridia usually biseriate. Female branches very short, margin lacinate, enclosing 2-8 biseriate archegonia. Perianth absent. Calyptra large, cylindrical or clavate, fleshy, always with papillæ at the apex. Capsule longly pedicellate, oblong-cylindric, opening by four valves to the base, wall of two layers of cells, cells with semi-annular bands. Spores small. Elaters short, attenuate, monospiral. Fixed elaters persistent as erect tufts on the apex of the valve.

*Note.*—The capsule has a columella-like structure projecting from the apex into the cavity of the capsule and bearing a number of fixed-elaters. On dehiscence this structure also divides into four pieces along with the four valves and the fixed-elaters remain attached to them sticking outwards.

Gemmæ are not uncommon in some species. They are usually 2-celled and are formed endogenously in the cells of the uppermost layer of the thallus, becoming free by the rupture of the cell wall.

*Key to the species.*

Thallus lobes broad, usually fleshy, plants oc-

curring singly or in patches . . . . . *A. indica.*

Thallus lobes long and very narrow, plants

densely overlapping . . . . . *A. Levieri*

101. *Aneura indica* St. (Ms.).

*Aneura indica* St. (Ms.); Kashyap, Jour. Bomb. Nat. Hist. Soc., Vol. XXV, p. 280 (1917).

Dioecious. Thallus simple or irregularly pinnately branched or forming rosettes, loosely attached to the humus or closely attached to the soil. Lobes up to 3 cm. long and 5 mm. broad, thick or thin, margin undulate, slightly raised or firmly fixed to the soil. No distinct midrib, thallus gradually thinning towards the margins; greatest thickness in the middle 8-13 cells. Cells of dorsal epidermis flat, convex or strongly papilliform. Male plants smaller, irregularly branched, branches rather long and narrow, thick, fleshy, margin turned upwards. Antheridia on small branches with a circular outline, restricted to the central part of the

dorsal surface. Archegonia with filamentous or small flat green scales. Sporogonium (from the South Indian specimens); seta 6 mm. long; capsule shortly cylindrical, 2.5 mm. long; both layers of the capsule wall with thick brown annular bands. Spores lamellate, with a broad margin, 20-30  $\mu$ . Elaters monospiral, 190  $\mu$  long.

Plate XXIX, figures 1-6.

Hab. Moist rocks, among grass and moss in the hills or on moist earth in the plains.

\*Distrib. Common. Western Himalayas, *Dalhousie*, *Sahasar Dhara* (3,000 ft.), *Mussoorie*, etc.; Lahul, *Kyelang* (11,000 ft.). Occasionally occurs in the Punjab plains also, *Lahore*, *Sialkot*. South India (Rangachariar); Palni Hills, 7,000 ft. (Mrs. Robinson).

*Note*.—This plant is extremely variable. In moist shady places in the hills the plants remain thin and light green, only loosely attached to the soil; while in exposed places (in the plains) the plants are thick, fleshy, deep green and firmly fixed to the soil. Dorsal epidermal cells of the plants from moist places are flat and of those from exposed places are convex to distinctly papillate. The dorsal epidermal cells of the male plants are always papillate. As a consequence the length of the upper epidermal cells is very variable.

Specimens of *Aneura* from the Punjab plain and Mussoorie were sent to Stephani in the beginning of 1914 for determination. He named them *Aneura indica* and *A. mussuriensis* respectively. A study of the specimens, however, from a large number of places in India, both from the plains and the hills, shows that the plant is very variable and the specimens referred to above belong to one and the same species. The name *A. indica* has, therefore, been given to this species. Some forms of the plant resemble *A. pinguis* (L.) Dum. very much.

#### 102. *Aneura* Levieri Schff. -

*Riccardia Levieri* Schff. Arb. bot. Inst. der k.k. deut. Univers. in Prag. Nr. XLIII (1899).



Plants brownish, densely overlapping in thick patches, very much branched in an irregularly pinnate manner, up to 10 mm. long. Lobes linear or linear-oblong, ultimate branches quadrate or obovate-oblong, or in very moist places linear. No distinct midrib. Main shoot up to 8 cells thick, biconvex in cross-section; cells all alike or epidermal cells rather small. Rest not seen.

Plate XXIX, figure 7.

Hab. Moist rocks.

Distrib. *Chamba-Chuari* Road, 6,000 ft.; Pangri, in running water, near *Shaichu*, 8,000 ft.; *Alwas-Silrundi* Road, 8,000-10,000 ft.; Palni Hills, South India, 7,000 ft. (Mrs. Robinson.)

*Note.*—The Pangri specimens are much longer, up to 40 mm., but the older parts are dead. They are also thinner and the ultimate lobes are oblong or linear-oblong.

There is a specimen of a species of *Aneura* labelled *Aneura pinguis* Dum. collected from Boshar in June, 1864, at the herbarium of the Forest Research Institute, Dehra Dun. Stephani (Sp. Hep., Vol. I, pp. 272-273) has also reported this species from the Himalayas which is according to him very widely distributed in the whole world. The following description is given after him.

### 103. *Aneura pinguis* (L.) Dum.

*Jungermannia pinguis* L., Sp. Pl. ed. 1, p. 1136 (1753).

*Aneura pinguis* (L.) Dum., Comment., p. 115 (1822).

Dioecious, broadly linear or ligulate, thick, green or yellowish green, in large patches. Thallus up to 2 cm. long, furcate, fixed by numerous rhizoids, lobes divergent, simple, canaliculate, 3 mm. broad, midrib broad, 8 cells thick, strongly produced on the lower side, abruptly passing into the wings, wings obtuse, entire, ascending, crisped, inner cells of the thallus much larger than the epidermal cells. Male branches pseudo-lateral from the thallus, oblong, sometimes with rhizoids, short, often 2- or 3-lobed, lobes ovate, wings thin, spreading, 3 cells broad, four pairs of antheridia, occasionally in three rows. Female branches pseudo-lateral from the main shoot, shortly and thinly laciniate at the apex, covered

by a margin of the thallus. Calyptra cylindrical, at maturity 8 mm. long, smooth, mamillæ small, highly papillate. Spores reddish, minutely papillate,  $18\ \mu$ . Elaters up to  $200\ \mu$ , reddish, laxly spiraled, narrowly attenuated at the apex.

Hab. Himalaya (Duthie).

\* \* \* \* \*

## XXVIII. METZGERIA Raddi.

*Metzgeria* Raddi in Att. Soc. Scient. Mod. 18, p. 34 (1818).

Thallus membranous, usually dichotomously or sometimes pinnately branched, with ventral innovations arising from the sides of the midrib. Midrib slender, sharply defined from the wings, wing of one layer of cells. Sex organs on greatly reduced ventral branches. Antheridia few, shortly pedicellate, globose. Female branch curved into an obcordate involucre furnished with hairs. Perianth absent. Calyptra thick, fleshy, clavate, hairy. Capsule shortly pedicellate, oblong-oval, 4-valved, wall of two layers of cells, the outer with nodular thickenings, the inner with indistinct annular bands. Spores small, spherical, smooth or minutely papillate. Elaters long, attenuate, monospiral, the spiral band broad, reddish brown. Fixed elaters partly persistent as erect tufts on the apex of the valves. Gemmæ discoid to linear.

*Note.*—The genus is at once recognised by the distinct midrib and 1-layered wing.

### *Key to the species.*

- |  |                        |
|--|------------------------|
| Plants with straight bristles all over the surface and the margins .. ..                           | <i>M. pubescens</i>    |
| Plants with long slender hairs only on the under-surface of the midrib and along the margins .. .. | <i>M. himalayensis</i> |

### . 104. *Metzgeria pubescens* Raddi.

*Metzgeria pubescens* Raddi in Att. Soc. Scient. Mod. 18, p. 46 (1818).

Diœcious. Plants forming rather large patches on rocks, or thin layers on mosses, etc. yellowish green. Thallus up to 50 mm. long and 2 mm. broad, irregularly pinnate or more or less

distinctly dichotomous, margin undulate, wing sometimes interrupted; thickly beset on both surfaces and margins with straight bristles. Ventral innovations very common. Midrib subterete, highly and almost equally arched on both surfaces. Cells of the wing 5-6-angled, not elongate,  $32-40\ \mu$  in diameter, walls thin, angles hardly thickened. Male branch with hairs only on the postical surface. Female branch with hairs on both surfaces.

Plate XXX, figures 1-3.

Hab. Moist shady rocks.

Distrib. Common, 7,000-10,000 ft. *Dalhousie-Chamba* Road; — *Chamba-Pangi* Road; Kulu, *Bhaboo Pass*; Kumaon, *Mussoorie*, near *Gangotri*; Kashmir, *Burzil Valley*, 10-11,000 ft. (Duthie); *Tehri-Garhwal*, *Chansil range*, 10-12,000 ft. (Duthie), *Boshar*, (Herb., F.R.I., *Dehra Dun*), etc.

*Note*.—The plant can be very easily recognised by the densely arranged bristles on both surfaces of the thallus (midrib as well as the wings) and along the margins. The plant varies greatly in size and mode of branching. Some plants are long and robust extending up to 50 mm. in length, and up to 2 mm. in breadth of lobes, and are always pinnate. Others are much smaller, delicate, not exceeding 1 mm. in breadth and they are more or less distinctly dichotomous. Intermediate forms are also met with.

#### 105. *Metzgeria himalayensis* Kashyap.

*Metzgeria himalayensis* Kashyap, Jour. Bomb. Nat. Hist. Soc., Vol. XXVI, p. 280 (1917).

*Metzgeria curviseta*-St., Sp. Hep., Vol. VI, p. 49 (1917).

Monœcious. Plants deep green, dichotomous, up to 15 mm. or more long. Lobes up to 4 mm. long and up to 1 mm. broad. Midrib biconvex, lamina plane or undulate, occasionally interrupted. Long hairs present on the under-surface of the midrib and along the margins, the rest naked. Midrib 4-6 cells thick and 3-4 cells broad through the centre. Epidermal cells of the midrib 2/2. Lamina in older parts up to 14 cells on each side; cells  $32\ \mu \times 30\ \mu$ . Male branches without hairs. Female branches with numerous hairs.

Plate XXX, figures 4-6.

Hab. Moist places.

Distrib. Fairly common from 5,000-9,000 ft. *Dalhousie*; Kulu, *Bhaboo Pass*; *Mussoorie*; Kaj Nag, 12-13,000 ft. (Duthie), *Chandar Tal*, 12,000 ft. (Gamble) (Herb., F.R.I., Dehra Dun), etc.

*Note*.—The number of hairs on the thallus in this species varies very greatly. Sometimes there is a regular fringe all along the margin and many hairs may be met with on the ventral side of the midrib. In other cases only a few hairs are met with here and there on the margin and none may occur on the midrib. The hairs may be straight, long and slender, or hamate.

There is a specimen in the herbarium of the Forest Research Institute, Dehra Dun, labelled *M. furcata* (L.) Lindb. from Boshar, but it is not so far reported from India. The following description is after Stephani (Sp. Hep., Vol. I, p. 289, 1899).

#### 106. *Metzgeria furcata* (L.) Lindb.

*Jungermannia furcata* L., Sp. Pl., p. 1136 (1753).

*Metzgeria furcata* Dum., Rec. d'obs., p. 26 (1835).

*Metzgeria furcata* (L.) Lindb. Monogr. Metzg., p. 35 (1877).

Dioecious, small, pale, on bark, dense, depresso-caespitose. Thallus furcate, subplane, apex rounded. Midrib thin, antical two cells broad, postical four cells broad, cells small and narrowly rectangular, ventral surface with long hairs. Wings scarcely decurved, more or less densely hairy, hairs long, distributed up to the margins; hairs on the margin absent. Cells of the wing  $36\ \mu \times 27\ \mu$ , those near the midrib longer, trigones small. Female branches obcordate, plano-convex, longly and sparsely hairy. Calyptra clavate-pyriform, more or less hairy.

Hab. Himalaya (Boshar).

Gola (Atti Della R. Accad. Delle Sci. Di Torino, Vol. XLIX, 1914) has reported *M. conjugata* Lindb. from Kashmir, but we have not seen this. The following description is after Stephani (Sp. Hep., Vol. I, p. 299, 1899).

107. *Metzgeria conjugata* Lindb.

*Metzgeria conjugata* Lindb. Monogr. Metzg., p. 29 (1877).

Monœcious, medium, dense-cæspitose. Thallus repeatedly furcate, convex, apex obtuse. Midrib ventrally produced, bounded by 6 cells, 2 antical and 4 postical, postical small with long hairs. Wing strongly decurved, naked, margins with more or less numerous hairs, hairs short, straight, in pairs, divergent. Cells of the wing  $65\ \mu \times 40\ \mu$ , trigones absent. Female branch with long hairs on the dorsal surface of the margin; calyptra with numerous bristle-like hairs.

Hab. Kashmir.

## SPHÆROCARPALES.

Gametophyte a thallus, without air-chambers and pores. Rhizoids smooth. Each antheridium and archegonium enclosed in a special envelope. Sporogonium with a large foot and a short seta. Capsule wall one-layered without fibrous bands on the cells. Sterile cells thin-walled and disappearing at maturity. Dehiscence irregular.

### FAMILY XIII. RIELLACEÆ.

Aquatic. Thallus erect or ascending, with a dorsal vertical wing and lateral leaves. Other characters the same as those of the Order.

\* \* \* \* \*

### XXIX. RIELLA Mont.

*Riella* Mont., Ann. Sc. Nat. 3, XVIII, p. 11 (1852).

Plants thallose, small or medium, delicate, light green, erect or ascending, with thin-walled rhizoids at the base, under water, occasionally on moist soil when water has flown away. Midrib in section elliptical, central cells elongated, cortical cells parenchymatous. Branching furcate. Wing arising from the dorsal side of the midrib, 1-layered, delicate, narrow at the base, well-developed above, falcate-rotund at the apex; margin entire or slightly lobed or incised, plane or slightly undulate. Leaves on the dorsal side, on both sides at the base of the wing, rudimentary or well-developed. Antheridia on the margin of the wing, immersed, in rows, shortly pedicellate, ovoid, each surrounded by an envelope, papillae inconspicuous. Archegonia from the dorsal side of the midrib, each surrounded by an involucre; involucre large, 1-layered, ovoid, in the upper portion more or less inflated, opening small. Calyptra strong, 2-layered. Capsule spherical, wall 1-layered, pedicel short, foot thick. Spores large, tetrahedral, minutely reticulate-lamellate. Sterile cells a little smaller than the spores, hyaline, without any spiral bands.

*Note.*—The dorsal wing distinguishes this genus from all other liverworts, and the plants of this genus are always aquatic. The sterile cells are disorganised when the spores are ripe.

108. *Riella indica* St. (Ms.)

*Riella indica* St. (Ms.), Kashyap, Jour. Bomb. Nat. Hist. Soc., Vol. XXV, p. 279 (1917).

Plants submerged, erect or ascending, firmly fixed to the mud by the rhizoids, often in dense patches, light green, simple or once or twice forked, up to 10 mm. long. Often many branches are given off from the base and plants have a tufted habit. Wing well-developed in early stages, up to 2 mm. broad, in the fertile portion small and interrupted. Lateral leaves (bracts) long and narrow, linear, conspicuous. Involucres up to six on each plant, densely situated, cylindrical, pointed, up to 2 mm. long, cells papilli-form. Spores reticulate on the convex side, 7-8 reticulations in the diameter, the angles projecting as spines, merely spinous on the flat sides, 60-70  $\mu$ .

Plate XXXI.

Hab. In shallow water in a water channel of the Shalamar Garden, Lahore; occasionally on mud.

*Note.*—The plants were first found in the months of February and March of 1913 and 1914. This is the only species of the genus so far found in India.

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FAMILY XIV. SPHÆROCARPACEÆ.

Thallus without a distinct midrib, of one layer of cells towards the margin, entire or lobed, involucres of sex organs closely grouped, pear-shaped or conical. Spores usually permanently united in tetrads.

Not represented by any species in this area.

## SYNOPSIS.

### JUNGERMANNIALES.

#### Family I, Lejeuneaceæ.

##### Genus I, Frullania.

- 1, *F. squarrosa*.
- 2, *F. retusa*.
- 3, *F. muscicola*.
- 4, *F. gracillima*.
- 5, *F. pyriflora*.
- 6, *F. Grevilleana*.
- 7, *F. Gollani*.
- 8, *F. himalayensis*.
- 9, *F. Duthiana*.

##### Genus II, Lejeunea.

- 10, *L. (Ptychanthus) Perrottetii*.
- 11, *L. (Ptychanthus) chinensis*.
- 12, *L. sp. A*.
- 13, *L. sp. B*.
- 14, *L. sp. C*.
- 15, *L. sp. D*.
- 16, *L. (Physocolea) sp. E*.
- 17, *Ptychanthus striatus*.

#### Family II, Madothecaceæ.

##### Genus III, Madotheca.

- 18, *M. appendiculata*.
- 19, *M. campylophylla*.
- 20, *M. Gollani*.
- 21, *M. plumosa*.
- 22, *M. denticulata*.
- 23, *M. acutiphylla*.
- 24, *M. variabilis*.
- 25, *M. platyphylla*.
- 26, *M. decurrens*.
- 27, *M. Gambleana*.



- 28, *M. macroloba*.
- 29, *M. gracillima*.
- 30, *M. obtusifolia*.
- 31, *M. angusta*.
- 32, *M. hastata*.
- 33, *M. ovalis*.
- 34, *M. trigonifolia*.
- 35, *M. virens*.
- 36, *M. densiramea*.
- 37, *M. densifolia*.
- 38, *M. Borellii*.

Family III, *Pleuroziaceæ*.

Not represented by any species.

Family IV, *Radulaceæ*.

Genus IV, *Radula*.

- 39, *R. complanata*.
- 40, *R. grandifolia*.
- 41, *R. Douleana*.
- 42, *R. Lindbergii*.

Family V, *Scapaniaceæ*.

Genus V, *Diplophyllum*.

- 43, *D. orientale*.

Genus VI, *Scapania*.

- 44, *S. verrucosa*.
- 45, *S. purpurea*.
- 46, *S. parva*.

Family VI, *Ptilidiaceæ*.

Genus VII, *Anthelia*.

- 47, *A. julacea*.

Genus VIII, *Blepharostoma*.

- 48, *B. trichophyllum*.

Family VII, *Cephaloziaceæ*.

Genus IX, *Lepidozia*.

- 49, *L. reptans*.

Genus X, *Mastigobryum*.

- 50, *M. triangulare*.

## Genus XI, Calypogeia.

51, *C. renistipula*.

## Genus XII, Cephalozia.

52, *C. Gollani*.

## Family VIII, Lophoziaceae.

## Genus XIII, Chiloscypus.

53, *C. inflatus*.54, *C. argutus*.55, *C. himalayensis*.56, *C. polyanthus*.57, *C. campanulatus*.58, *C. Gollani*.

## Genus XIV, Lophocolea.

59, *L. bidentata*.60, *L. heterophylla*.61, *L. minor*.62, *L. alata*.

## Genus XV, Plagiochila.

63, *P. mundaliensis*.64, *P. simlana*.65, *P. Mittenii*.66, *P. ferruginea*.67, *P. accedens*.68, *P. sp. A.*69, *P. sp. B.*70, *P. himalayensis*.71, *P. Duthiana*.72, *P. cavifolia*.73, *P. Gollani*.74, *P. grata*.75, *P. nana*.76, *P. asplenioides*.

## Genus XVI, Lophozia.

77, *L. alpestris*.78, *L. incisa*.79, *L. sp.*80, *L. piacenzai*.

Genus XVII, *Jamesoniella*.

81, *J. elongella*.

Genus XVIII, *Solenostoma*.

82, *S. lanceolata*.

83, *S. crenulata*.

84, *S. breviflora*.

85, *S. purpurata*.

Genus XIX, *Jungermannia*.

86, *J. oblongifolia*.

87, *J. viridis*.

88, *J. humilis*.

89, *J. Duthiana*.

90, *J. tenerrima*.

Genus XX, *Southbya*.

91, *S. Gollani*.

Family IX, *Calobryaceæ*.

Not represented by any species.

Family X, *Codoniaceæ*.

Genus XXI, *Fossombronina*.

92, *F. himalayensis*.

Genus XXII, *Sewardiella*.

93, *S. tuberifera*.

Genus XXIII, *Petalophyllum*.

94, *P. indicum*.

Genus XXIV, *Blasia*.

95, *B. pusilla*.

Genus XXV, *Pellia*.

96, *P. calycina*.

97, *P. epiphylla*.

98, *P. Neesiana*.

Genus XXVI, *Calycularia*.

99, *C. crispula*.

100, *C. compacta*.

Family XI, *Blyttiaceæ*.

Not represented by any species.

Family XII, *Aneuraceæ*.

Genus XXVII, *Aneura*.

101, *A. indica*.

102, *A. Levieri*.

103, *A. pinguis*.

Genus XXVIII, *Metzgeria*.

104, *M. pubescens*.

105, *M. himalayensis*.

106, *M. furcata*.

107, *M. conjugata*.

Sphærocarpales

Family XIII, *Riellaceæ*.

Genus XXIX, *Riella*.

108, *R. indica*.

Family XIV, *Sphærocarpaceæ*.

Not represented by any species.

## APPENDIX I.

### CLIMATIC DETAILS OF SOME IMPORTANT PLACES.

#### LAHORE.

Height above sea level .. ..	700'.
Average annual rainfall .. ..	19·58".

In summer the temperature goes up to 115° F. or sometimes even more. In winter, during the nights the temperature on the grass falls below 32° F. and for a couple of months there is hoar frost of 5° to 10°. The rain falls mostly in July and August, but a small amount falls in winter also. The summer is very hot and dry, being quite hostile to the growth of tiny and delicate plants like Liverworts.

#### SIMLA.

Height above sea level .. ..	6,000' to 8,000'.
Average annual rainfall .. ..	63".

The mean maximum temperature in winter (December to February) ranges between 49·4° F. and 44·5° F. and the mean minimum temperature between 30·1° F. and 34·5° F. The mean maximum temperature in summer (in July, the hottest month) is 74·4° F. and the mean minimum is 61·0° F.

Snow falls in winter which is the resting season. The rain chiefly falls from July to September.

#### MUSSOORIE.

Height above sea level .. ..	6,000' to 8,000'.
Average annual rainfall .. ..	109·69".

The climate is very much like that of Simla. As the station has got a moist and humid climate the Hepatic flora is very rich.

#### DALHOUSIE.

Height above sea level .. ..	6,000' to 8,000'.
Average annual rainfall .. ..	83·88".

Being further north-west to the above-mentioned stations the climate is not as suitable for Liverworts as that of the two stations given above. The vegetation, therefore, is a little less luxuriant.

#### KULU.

Height above sea level.....(Nagar).....	5,780'.
Height above sea level.....(Sultanpur).....	4,000'.
Average annual rainfall.....(Nagar).....	49·4".
Average annual rainfall.....(Sultanpur).....	39·74".

Snow falls in winter at Nagar and the winter is severe in the higher lying tracts of Kulu, and in sheltered places snow lies well till April. The mean temperature from June to August at Sultanpur is about 75° F. Mean minimum from January to February 41° F. (Kulu Gazetteer).

#### CHAMBA.

Height above sea level .. .. .	3,027'.
Average annual rainfall .. .. .	47·6".
Mean maximum temperature .. .. .	77·7° F.
Mean minimum temperature .. .. .	56·5° F.

In the Ravi Valley, as elsewhere, the climatic conditions vary with the altitude. In the lower portion of the Valley from the capital downwards they are of a semi-tropical character. The heat is great and rainy season well marked, while the winter is mild and the snowfall light. In the capital the maximum temperature recorded is 108·3° F. and the minimum 30·3° F. From the capital upwards the conditions are more severe, and vary from temperate to semi-arctic. Arctic conditions prevail along the high ranges for several months in winter. In the Brahmaur Wizarat the summer is mild, but winter is severe (Chamba Gazetteer).

#### KYELANG.

Height above sea level .. .. .	10,000'.
Average annual rainfall including winter (melted) snow .. .. .	23".
Average annual rainfall not including winter snowfall .. .. .	6".

The climate of Lahul is most bracing. The air is crisp and keen especially in the Valley of the Chandra; that of the Bhaga Valley at Kyelang has not quite the same vigorous quality. The maximum temperatures at Kyelang range from  $33\cdot3^{\circ}$  F. in February to  $73\cdot6^{\circ}$  F. in August, the minimum from  $13\cdot4^{\circ}$  F. in February to  $50\cdot2^{\circ}$  F. in July. Lahul is set in a basin, the edge of which consists of enormous mountain ranges. The barriers keep off the monsoon currents, causing the rain to spend itself on their south and west faces. In consequence the summer rainfall in Lahul is scanty, affecting on the average no more than three days in each month. The total rainfall during the whole season from June to September is about 6". On the other hand nearly three times as much precipitation occurs during the period of December to May, and is then associated mainly with storms of high elevation which traverse Northern India from west to east and pass over the mountains which obstruct the monsoon in summer (Kulu Gazetteer).

In the Chandra Bhaga Valley the climate is temperate in summer and semi-arctic in winter. As the lowest altitude in the Pangi Valley is 7,000 feet, no great heat is felt. The summer is exceedingly mild and pleasant, while owing to the scanty rainfall the degree of humidity is always low. The winter, however, is very severe. Snow commences to fall in October but does not lie permanently till December, after which the whole valley is under snow till March or April (Chamba Gazetteer).

#### LEH (LADAK).

Height above sea level	..	..	11,000'.
Average annual rainfall	..	..	3".

Winter is very severe. Cold and dry winds are prevalent in the whole of Ladak. Trees are met with only in low-lying sheltered places. In Rupshu the altitude of the plateau is from 13,000 feet to 16,000 feet at different places, and the climate is extremely rigorous. There are absolutely no trees there.

## APPENDIX II.

## LIVERWORTS OF CERTAIN LOCALITIES.

## 1. Panjab plain (Lahore, etc.).

1. *Anthoceros himalayensis*, Lahore.
2. *Anthoceros chambensis*, rare, Sialkot, Wah.
3. *Marchantia palmata*, common, everywhere.
4. *Marchantia nepalensis*, common, everywhere.
5. *Cyathodium tuberosum*, rare, Jullundur.
6. *Fimbriaria pathankotensis*, fairly common, Lahore.
7. *Grimaldia indica*, rare, Amritsar, Lahore.
8. *Reboulia hemispherica*, rare, Lahore.
9. *Plagiochasma appendiculatum*, common, Lahore.
10. *Plagiochasma articulatum*, rare, Lahore.
11. *Riccia pathankotensis*, rare, Lahore.
12. *Riccia himalayensis*, rare, Lahore.
13. *Riccia robusta*, common, Lahore.
14. *Riccia cruciata*, common, Lahore.
15. *Riccia sanguinea*, very common along rivers everywhere.
16. *Aneura indica*, rare, Sialkot, Lahore.
17. *Fossombronia himalayensis*, rare, Lahore.
18. *Petalophyllum indicum*, fairly common on riverside, Lahore.
19. *Riella indica*, rare, Lahore.
20. *Jungermannia humilis*, rare, Lahore, Amritsar.

The number of species becomes larger and individuals of each species more numerous as we go to the foot of the hills. The two species of *Plagiochasma*; *Grimaldia indica*, *Fimbriaria pathankotensis*, *Riccia pathankotensis* and *Riccia himalayensis* become particularly common. *Ricciocarpus natans* and *Riccia fluitans* are met with at Peshawar.

## 2. Pangi and Lahul (Chandra Bhaga Valley)

8,000 ft. to 10,000 ft.

1. *Marchantia polymorpha*, fairly common.
2. *Preissia quadrata*, very common.
3. *Dumortiera hirsuta*, not common.



4. *Fimbriaria reticulata*, above Kyelang.
5. *Grimaldia indica*, above Kyelang.
6. *Reboulia hemispherica*, common.
7. *Athalamia pusilla*, above Kyelang.
8. *Riccia robusta*, above Kyelang.
9. *Aneura indica*, Kyelang.
10. *Pellia calycina*, common.
11. *Pellia epiphylla*, Shaichu.
12. *Calycularia compacta*, Kyelang.
13. *Madotheca appendiculata*.
14. *Madotheca platyphylla*.
15. *Madotheca Gambleana*.
16. *Madotheca macroloba*.
17. *Madotheca gracillima*.
18. *Chiloscyphus inflatus* from Chandra Dal by Gamble.

The following have been met with in the Chandra Valley above 13,000.

19. *Sauchia spongiosa*, Dokpo Gongma, about 15,000 feet, and just below the top of the Manh pass.
20. *Riccia robusta*, Chandra Dal.

### 3. Spiti.

1. *Marchantia polymorpha* (probably).
2. *Preissia quadrata*.
3. *Reboulia hemispherica*.
4. *Riccia robusta*.

Specimens were collected only between the Manh pass (going from the Chandra Valley) and Losar.

### 4. Transhimalayan region (Ladak, etc.).

1. *Marchantia polymorpha*, beyond the Baralacha pass near Kinlung, about 15,000 feet; Kargil, Leh, etc.
2. *Preissia quadrata*, beyond the Baralacha pass near Kinlung, about 15,000 feet.
3. *Sauchia spongiosa*, beyond the Baralacha pass near Kinlung, a little below 15,000 feet.

4. *Plagiochasma articulatum*, Ladak.
5. *Madotheca ovalis* (Stephani, Sp., Hep.).
6. *Anthelia julacea*, Zanskar, about 12,000 to 13,000 feet.
7. *Blepharostoma trichophyllum*, Zanskar, about 12,000 to 13,000 feet.
8. *Lophozia alpestris*, Zanskar, about 12,000 to 13,000 feet.
9. *Lophozia incisa*, Zanskar, about 12,000 to 13,000 feet.

Only the upper part of the Zanskar Valley above Tangse has, however, been visited. More species may be expected in the lower parts. In the body of the book the name Rupshu has been used for the country beyond the Baralacha pass for geographical and climatic reasons but politically the part immediately beyond the pass is included in British Lahul whose boundary extends to a little beyond the Lingti plain.

### 5. Kashmir Valley.

The list is not quite complete, specially as there is a great range of altitude.

1. *Anthoceros* sp.
2. *Marchantia polymorpha*.
3. *Marchantia palmata*.
4. *Marchantia nepalensis*.
5. *Preissia quadrata*.
6. *Conocephalum conicum*.
7. *Reboulia hemispherica*.
8. *Plagiochasma appendiculatum*.
9. *Fimbriaria reticulata*.
10. *Fimbriaria* sp.
11. *Ricciocarpus natans*.
12. *Pellia calycina*.
13. *Sauchia spongiosa*.
14. *Riccia* sp.
15. *Frullania pyriformis*.
16. *Madotheca platyphylla*.
17. *Madotheca obtusifolia*.
18. *Madotheca trigonifolia*.

19. *Scapania parva*.
20. *Plagiochila Mittenii*.
21. *Plagiochila himalayensis*.
22. *Plagiochila Duthiana*.
23. *Plagiochila cavifolia*.
24. *Jungermannia Duthiana*.
25. *Fimbriaria Calciatii*.
26. *Metzgeria pubescens*.
27. *Lophozia Piacenzai*.
28. *Lophozia alpestris*.
29. *Plagiochila asplenoides*.
30. *Lepidozia reptans*.
31. *Radula Lindenbergiana*.
32. *Madotheca Borellii*.

Species Nos. 18-24 are reported by Stephani (Species Hepaticarum, Vols. I-VI).

Species Nos. 25-32 are reported by Golla (Atti Della R. Accademia Delle Scienze Di Torino, Vol. XLIX, 1914).

### APPENDIX III.

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# ALPHABETICAL INDEX TO GENERA, SPECIES, AND SYNONYMS.

(Synonyms are in *Italics*.)

	Page.		Page.
ANEURA Dum.	.. 106	himalayensis St.	.. 62
indica St.	.. 107	inflatus St.	.. 61
Levieri (Schiffn.) St.	.. 108	polyanthus (L.) Corda	.. 63
pinguis (L.) Dum.	.. 109	DIPLOPHYLLUM Dum.	47
ANTHELIA Dum.	.. 51	orientale St.	.. 47
julacea (L.) Dum.	.. 51	EUCALYX Breidl.	.. 86
Juratzkana (Limp.) Trev.	52	FOSSOMBRONIA Raddi	.. 92
APLOZIA Dum.	.. 82	himalayensis Kash.	.. 92
crenulata (Sm.) Dum.	.. 84	Levieri St.	.. 92
lanceolata (Schrad.) Dum.	83	FRULLANIA Raddi	.. 10
sphaerocarpa (Hook.) Dum.	85	Chinensis St.	.. 11
BAZZANIA Gray.	.. 56	Duthiana St.	.. 18
tricerenata (Wahl.) Pears	57	Gollani St.	.. 17
BELLINCINIA et ANTOIRIA		gracillima St.	.. 14
Raddi	.. 26	Grevilleana Tayl.	.. 16
BLASIA L.	.. 97	himalayensis St.	.. 17
pusilla L.	.. 98	musciola St.	.. 14
BLEPHAROSTOMA Dum.	52	pyriflora St.	.. 15
trichophyllum (L.) Dum.	53	retusa Mitt.	.. 13
CALYCVLARIA Mitt.	.. 102	squarrosa Nees	.. 11
crispula Mitt.	.. 103	HAPLOZIA K. Müll	.. 82
compacta Kash.	.. 105	crenulata (Sm.) Dum.	.. 84
CALYPOGEIA Raddi	.. 57	lanceolata (Schrad.) Dum.	83
renistipula St.	.. 58	JAMESONIELLA (Spruce)	
CEPHALOZIA Dum.	.. 58	Schiffn.	.. 81
Gollani St.	.. 59	elongella (Tayl.) St.	.. 81
CHILOSCYPHUS Corda	.. 60	JUNGERMANNIA L.	.. 86
argutus Nees	.. 62	alpestris Schleich	.. 79
campanulatus St.	.. 64	asplenioides L.	.. 77
Gollani St.	.. 64	bidentata L.	.. 66



	Page.		Page.
<i>campylophylla</i> L. et L. . .	29	<i>incisa</i> (Schrad.) Dum. . .	79
<i>complanata</i> L. . .	44	<i>Piacenzai</i> Gola . .	80
<i>crenulata</i> Sm. . .	84	sp. . .	80
<i>Duthiana</i> St. . .	88	<b>MADOTHECA</b> Dum. . .	26
<i>elongella</i> Tayl. . .	81	<i>acutifolia</i> L. et L. . .	32
<i>furcata</i> L. . .	112	<i>acutiphylla</i> Kash. . .	32
<i>heterophylla</i> Schrad. . .	67	<i>angusta</i> St. . .	38
<i>humilis</i> Kash. . .	88	<i>appendiculata</i> St. . .	28
<i>incisa</i> Schrad. . .	79	<i>Borellii</i> Gola . .	42
<i>lanceolata</i> L. . .	83	<i>campylophylla</i> L. et L. . .	29
<i>neckeroides</i> Griff. . .	29	<i>decurrens</i> St. . .	34
<i>oblongifolia</i> Kash. . .	87	<i>densifolia</i> St. . .	41
<i>pinguis</i> L. . .	109	<i>densiramea</i> St. . .	41
<i>platyphylla</i> L. . .	34	<i>denticulata</i> Kash. . .	31
<i>polyanthos</i> L. . .	63	<i>Gambleana</i> St. . .	35
<i>purpurata</i> Mitt. . .	85	<i>Gollani</i> St. . .	29
<i>reptans</i> L. . .	55	<i>gracillima</i> Mitt. . .	37
<i>tenerrima</i> St. . .	89	<i>hastata</i> St. . .	39
<i>triangularis</i> Schleich . .	57	<i>lævigata</i> (Schrad.) Dum. . .	39
<i>trichophylla</i> L. . .	53	<i>macroloba</i> St. . .	36
<i>viridis</i> , Kash. . .	87	<i>obtusifolia</i> Kash. . .	38
<b>LEJEUNEA</b> Libert. . .	18	<i>ovalis</i> G. . .	39
sp. A. . .	22	<i>platyphylla</i> (L.) Dum. . .	34
sp. B. . .	22	<i>platyphylloidea</i> Dum. . .	39
sp. C. . .	23	<i>plumosa</i> Mitt. . .	30
sp. D. . .	24	<i>Porella</i> (Dicks.) Nees . .	33
sp. E. . .	24	<i>trigonifolia</i> St. . .	40
<b>LEPIDOZIA</b> Dum. . .	54	<i>variabilis</i> Kash. . .	33
<i>reptans</i> (L.) Dum. . .	55	<i>virens</i> St. . .	41
<b>LOPHOCOLEA</b> Dum. . .	65	<b>MARTINELLIUS</b> Gray . .	44
<i>alata</i> Mitt. ex. Larter. . .	68	<b>MASTIGOBRYUM</b> Nees . .	56
<i>bidentata</i> (L.) Dum. . .	66	<i>triangulare</i> (Schleich) St. . .	56
<i>heterophylla</i> (Schrad.) Dum. . .	67	<b>METZGERIA</b> Raddi . .	110
<i>minor</i> Nees . .	67	<i>conjugata</i> Lindb. . .	113
<b>LOPHOZIA</b> Dum. . .	78	<i>curviseta</i> St. . .	111
<i>alpestris</i> (Schleich) Evans. . .	79	<i>furcata</i> (L.) Lindb. . .	112

	Page.		Page.
himalayensis Kash.	.. 111	sp. A. ..	.. 74
pubescens Raddi	.. 110	sp. B. ..	.. 74
<i>NARDIA</i> Gray	.. 84	<i>PORELLA</i> Dill	.. 26
<i>crenulata</i> Lindb.	.. 84	<i>PTYCHANTHUS</i> Nees	.. 20
<i>PELLIA</i> Raddi	.. 99	<i>chinensis</i> St.	.. 21
<i>calycina</i> (Tayl.) Nees	.. 100	<i>Perrottetii</i> St.	.. 20
<i>epiphylla</i> (L.) Lindb.	.. 101	<i>striatus</i> Nees	.. 25
<i>Fabbroniana</i> Raddi	.. 100	<i>RADULA</i> Dum.	.. 44
<i>Neesiana</i> (G.) Limp.	.. 102	<i>complanata</i> (L.) Dum.	.. 44
<i>PETALOPHYLLUM</i> G.	.. 96	<i>Douleana</i> St.	.. 45
<i>indicum</i> Kash.	.. 96	<i>grandifolia</i> St.	.. 45
<i>PHYSOCOLEA</i> Spruce	.. 24	<i>Lindbergii</i> G.	.. 46
<i>madothecoides</i> St.	.. 25	<i>RIELLA</i> Mont.	.. 114
<i>producta</i> (Mitt.) St.	.. 25	<i>indica</i> St. ..	.. 115
sp. ..	.. 24	<i>SCAPANIA</i> Dum.	.. 48
<i>PLAGIOCHILA</i> Dum.	.. 69	<i>orientalis</i> St.	.. 47
<i>accedens</i> St.	.. 73	<i>parva</i> St. ..	.. 50
<i>ambigua</i> Mitt.	.. 72	<i>purpurea</i> Kash.	.. 49
<i>asplenioides</i> (L.) Dum.	.. 77	<i>verrucosa</i> Heeg.	.. 49
<i>cavifolia</i> St. . .	.. 76	<i>SEWARDIELLA</i> Kash.	.. 93
<i>Duthiana</i> St.	.. 75	<i>tuberifera</i> Kash.	.. 94
<i>ferruginea</i> St.	.. 72	<i>SOLENOSTOMA</i> Mitt.	.. 82
<i>Gollani</i> St. . .	.. 76	<i>breviflora</i> Kash.	.. 85
<i>grata</i> St. . .	.. 77	<i>crenulata</i> (Sm.) St.	.. 84
<i>himalayensis</i> St.	.. 75	<i>lanceolata</i> (L.) St.	.. 83
<i>Mittenii</i> St. . .	.. 72	<i>purpurata</i> (Mitt.) St.	.. 85
<i>mundaliensis</i> St.	.. 71	<i>sphaerocarpa</i> (Hook.) St.	.. 85
<i>nana</i> St. . .	.. 77	<i>SOUTHBYA</i> Spruce	.. 89
<i>simlana</i> Mitt.	.. 71	<i>Gollani</i> St. . .	.. 90
		<i>STEPHANINA</i> O. Kuntze	.. 44



## PLATES.

PLATE I.

FRULLANIA SQUARROSA. 1—5.

1. A shoot, from below.
2. A shoot, from above.
3. A leaf. Note the appendage.
4. Upper cells.
5. Basal cells.

FRULLANIA RETUSA. 6—9.

6. A shoot, from below.
7. Another shoot, from below.
8. Upper cells.
9. Basal cells.

FRULLANIA MUSCICOLA. 10—12.

10. A shoot, from below.
11. Upper cells.
12. Basal cells.

FRULLANIA GRACILLIMA. 13—15.

13. A shoot, from below.
14. Upper cells.
15. Basal cells.

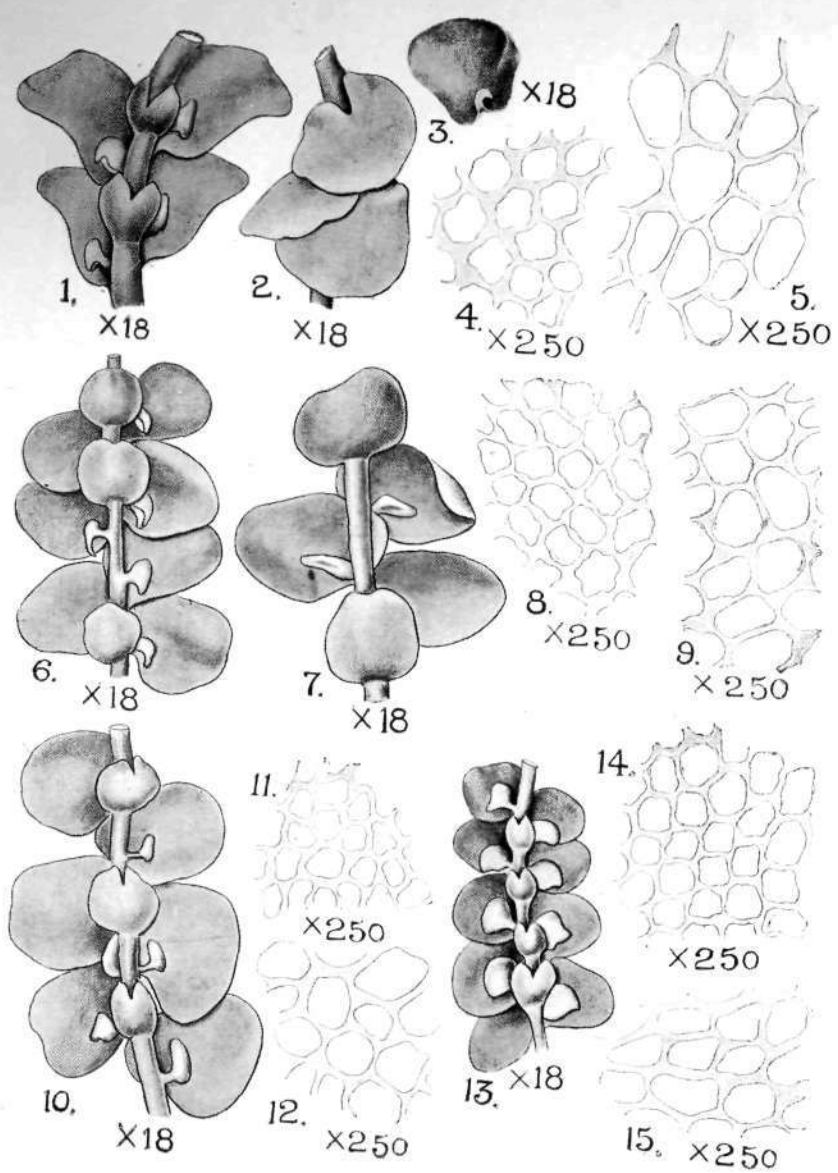


PLATE I.

PLATE II.

FRULLANIA PYRIFLORA. 1—3.

- 1-2. Two shoots, from below.
- 3. Median cells.

FRULLANIA GREVILLEANA. 4—7.

- 4. A shoot, from below.
- 5. A leaf.
- 6. Upper cells.
- 7. Basal cells.

LEJEUNEA (PTYCHANTHUS) PERROTTETII. 8—12.

- 8. A shoot, from below.
- 9. A leaf.
- 10. Perianth and involucre.
- 11. Upper cells.
- 12. Basal cells.

LEJEUNEA (PTYCHANTHUS) CHINENSIS. 13—15.

- 13. A shoot, from below.
- 14. Upper cells.
- 15. Basal cells.

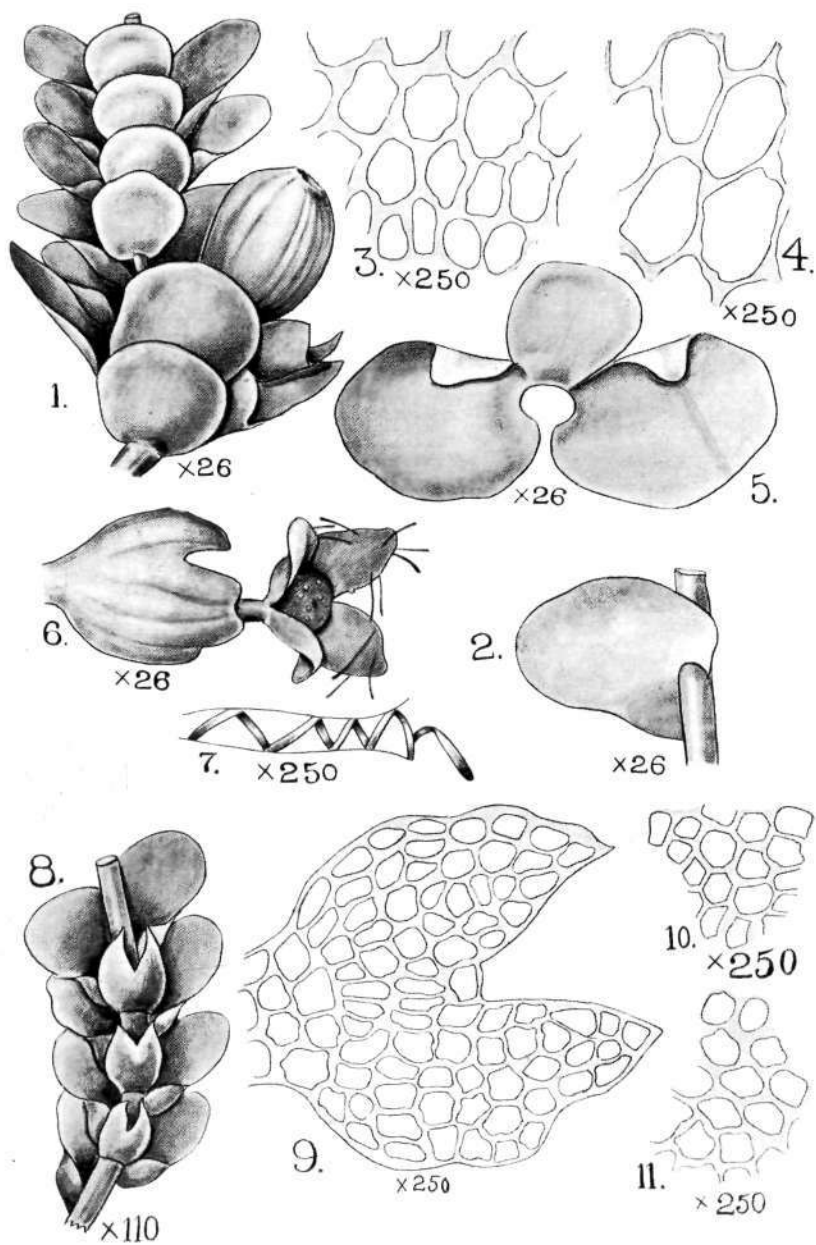


PLATE III.



PLATE III.

LEJEUNEA SP. A. 1—7.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Basal cells.
5. Involucre.
6. A perianth.
7. A part of an elater.

LEJEUNEA SP. B. 8—11.

8. A shoot, from below.
9. An amphigastrium.
10. Upper cells.
11. Basal cells.

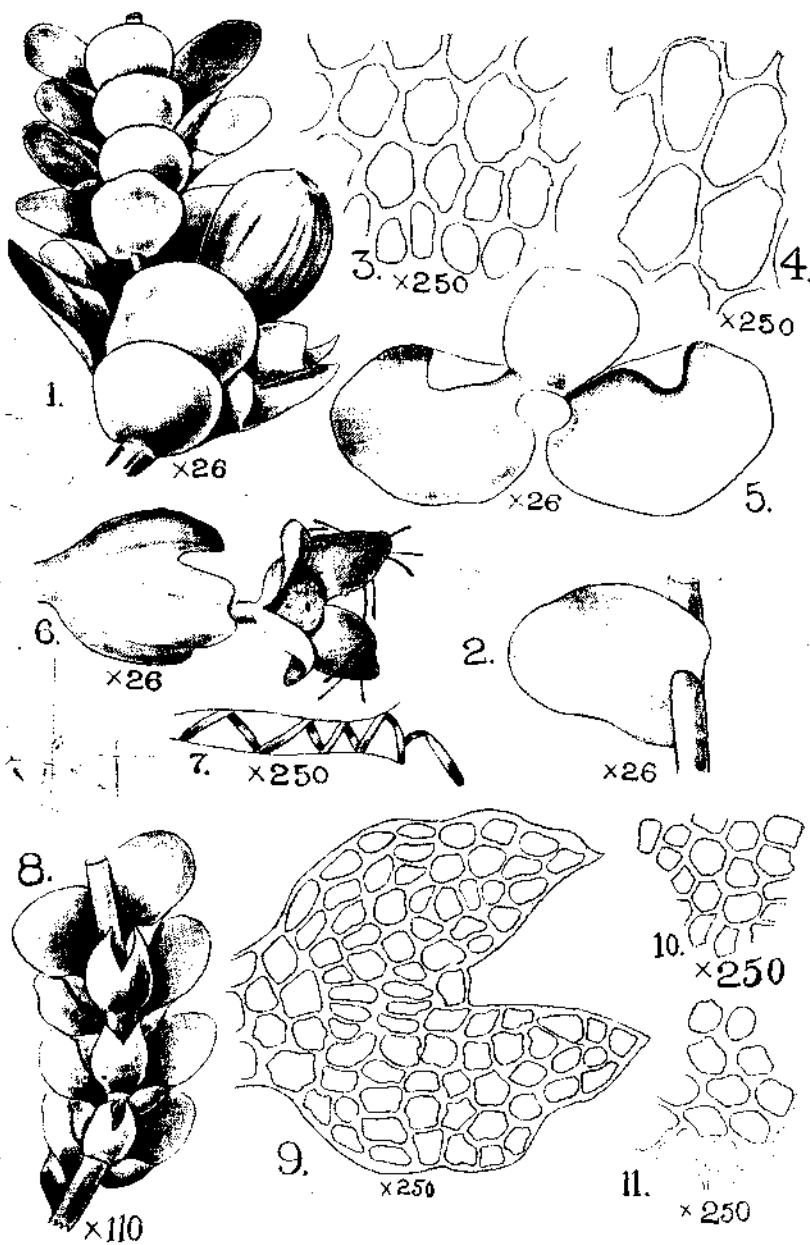


PLATE III.

PLATE IV.

LEJEUNEA SP. C. 1—4.

1. A shoot, from below.
2. A lobule, magnified.
3. Upper cells.
4. Basal cells.

LEJEUNEA SP. D. 5—7.

5. A shoot, from below.
6. A fertile shoot, from below.
7. Median cells.

LEJEUNEA (PHYSOCOLEA) SP. E. 8—11.

8. A fertile shoot, from below.
9. A leaf attached to the stem, from above.
10. Upper cells.
11. Basal cells.

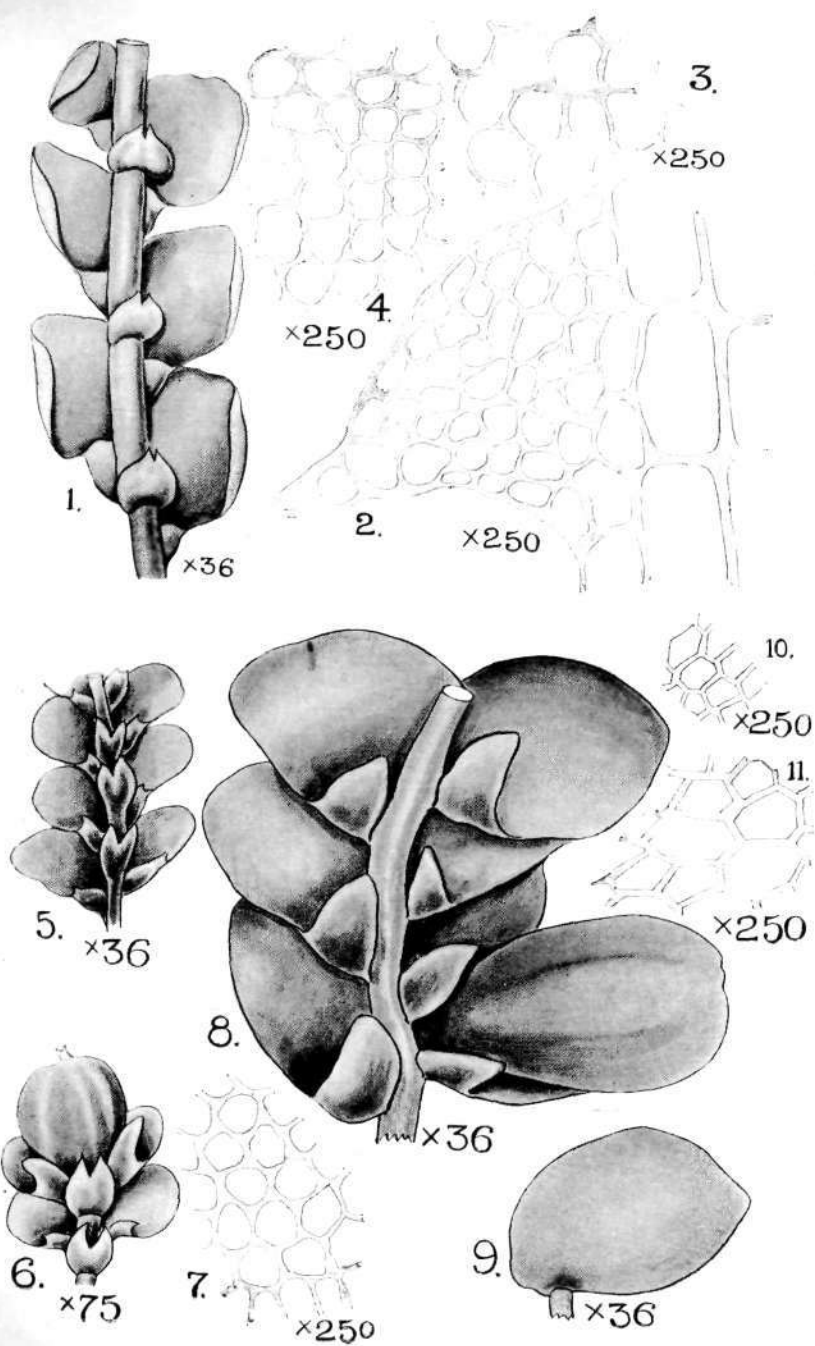


PLATE IV.

PLATE V.

MADOTHECA APPENDICULATA. 1—7.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Basal cells.
5. Perianth and involucre.
6. A spore.
7. An elater.

MADOTHECA CAMPYLOPHYLLA. 8—11.

8. A shoot, from below.
9. A leaf attached to the stem, from above.
10. Upper cells.
11. Basal cells.

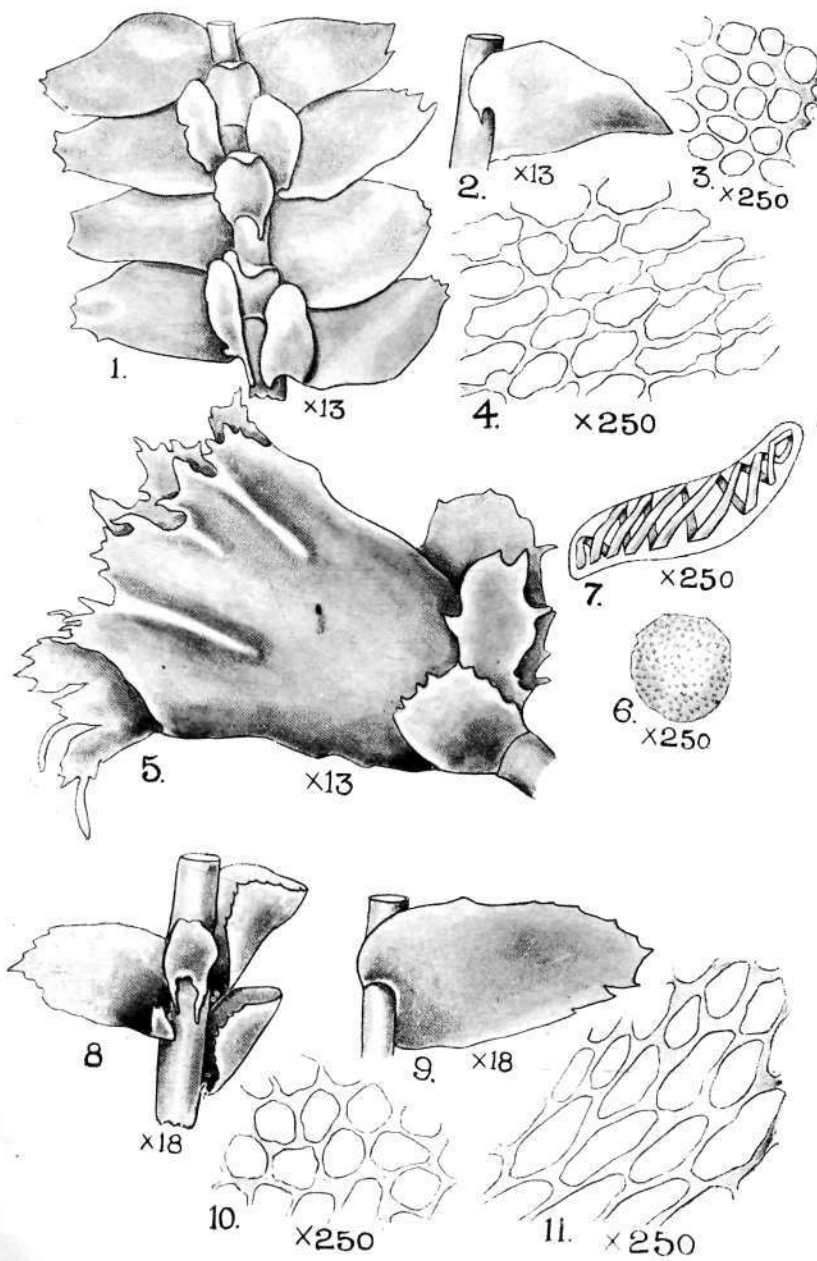


PLATE V.

PLATE VI.

MADOTHECA GOLLANI. 1—5.

1. A shoot, from below.
2. A leaf and lobule, from below.
3. A leaf attached to the stem, from above.
4. Upper cells.
5. Basal cells.

MADOTHECA PLUMOSA. 6—10.

6. A shoot, from below.
7. A leaf attached to the stem, from above.
8. Upper cells.
9. Median cells.
10. Basal cells.

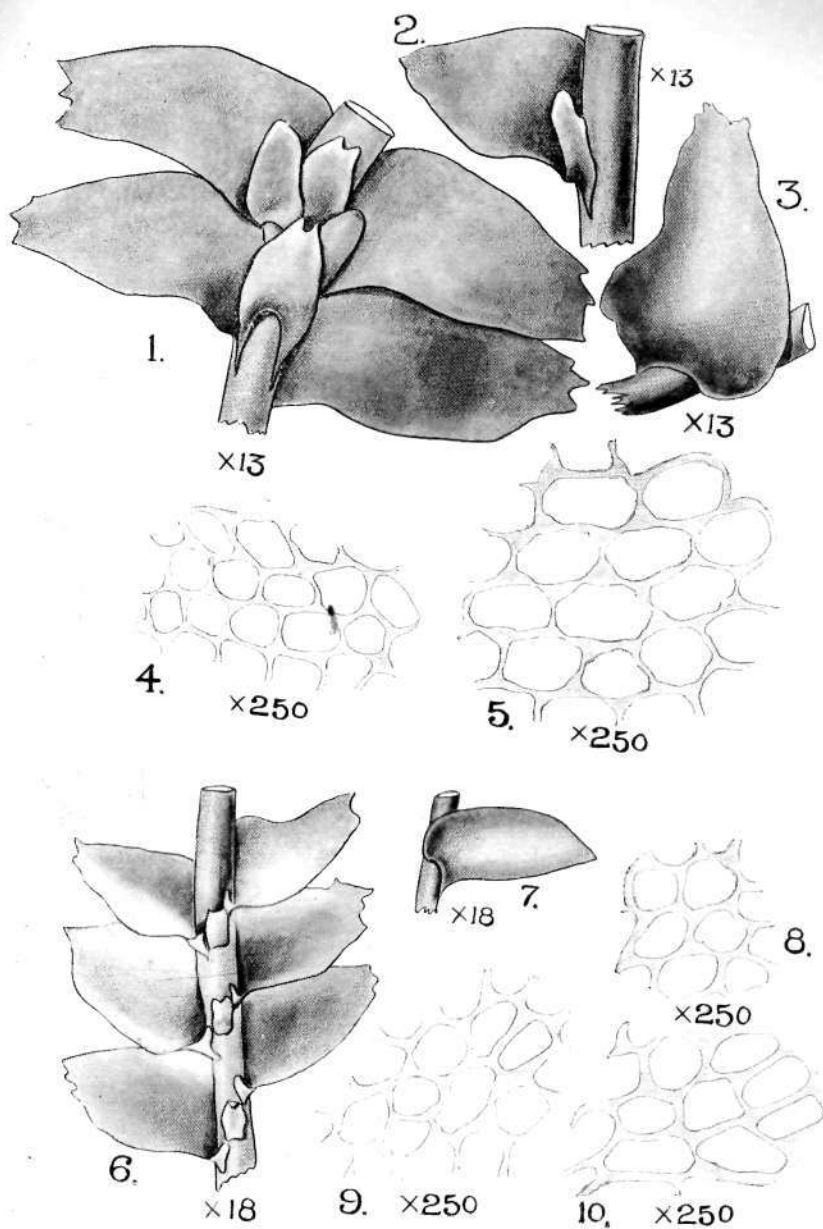


PLATE VI.



PLATE VII.

MADOTHECA DENTICULATA. 1—4.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Basal cells.

MADOTHECA ACUTIPHYLLA. 5—9.

5. A shoot, from below.
6. A leaf attached to the stem, from above.
7. Upper cells.
8. Median cells.
9. Basal cells.

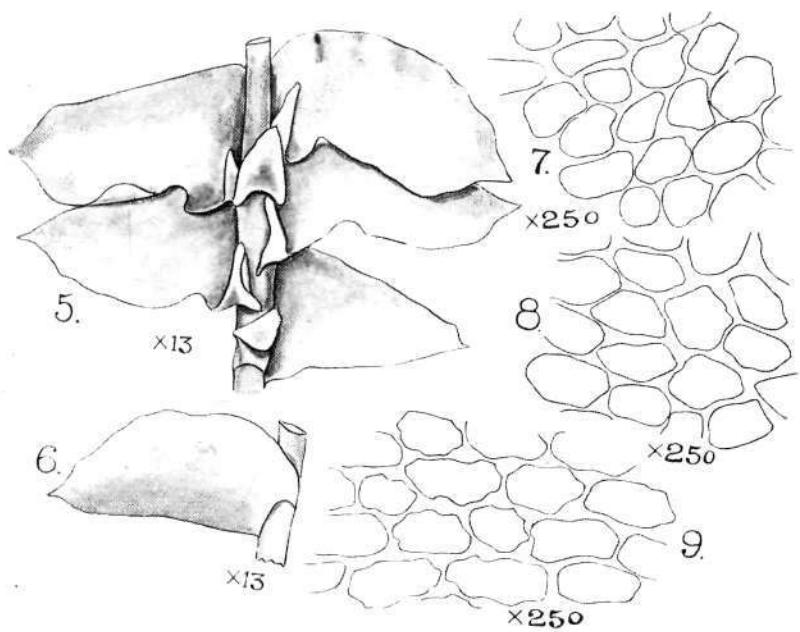
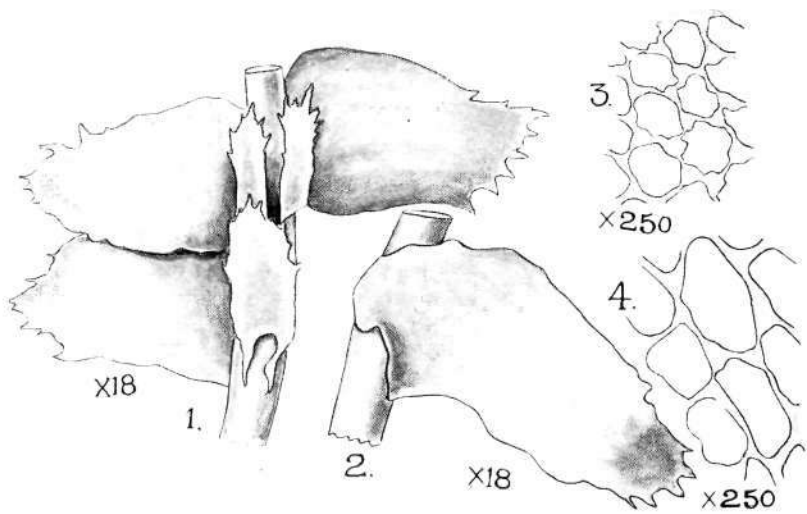


PLATE VII.

PLATE VIII.

MADOTHECA VARIABILIS. 1—5.

1. A shoot, from below.
2. Another shoot, from below.
3. A leaf attached to the stem, from above.
4. Upper cells.
5. Basal cells.

MADOTHECA PLATYPHYLLA. 6—10.

6. A shoot, from below.
7. A leaf attached to the stem, from above.
8. Upper cells.
9. Basal cells.
10. Involucre and perianth.

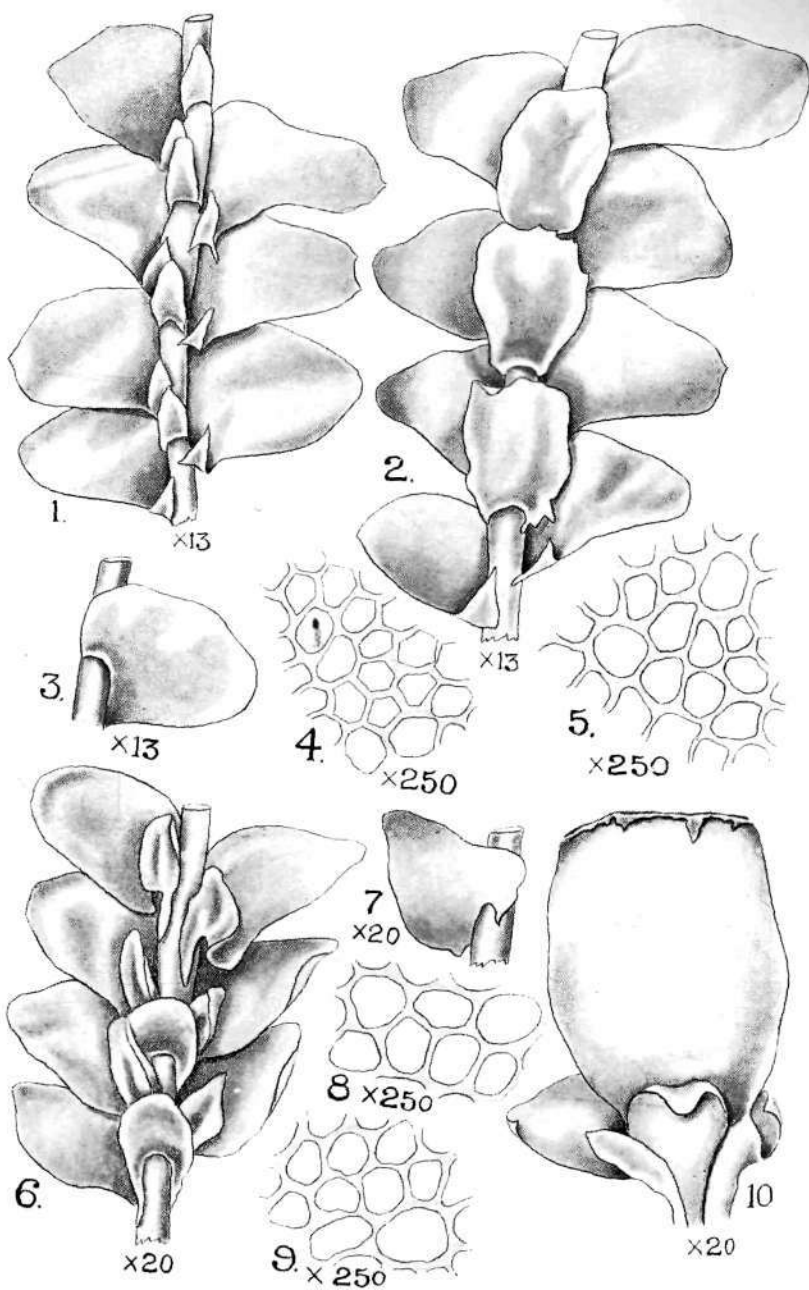


PLATE VIII.

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PLATE IX.

MADOTHECA DECURRENS. 1—4.

1. A shoot, from below.
2. Two leaves attached to the stem, from above.
3. Upper cells.
4. Basal cells.

MADOTHECA GAMBLEANA. 5—9.

5. A shoot, from below (only one lobule shown).
6. A leaf attached to the stem, from above.
7. Upper cells.
8. Basal cells.
9. A perianth and involucre.

MADOTHECA MACROLOBA. 10—13.

10. A shoot, from below.
11. A leaf attached to the stem, from above.
12. Upper cells.
13. Basal cells.

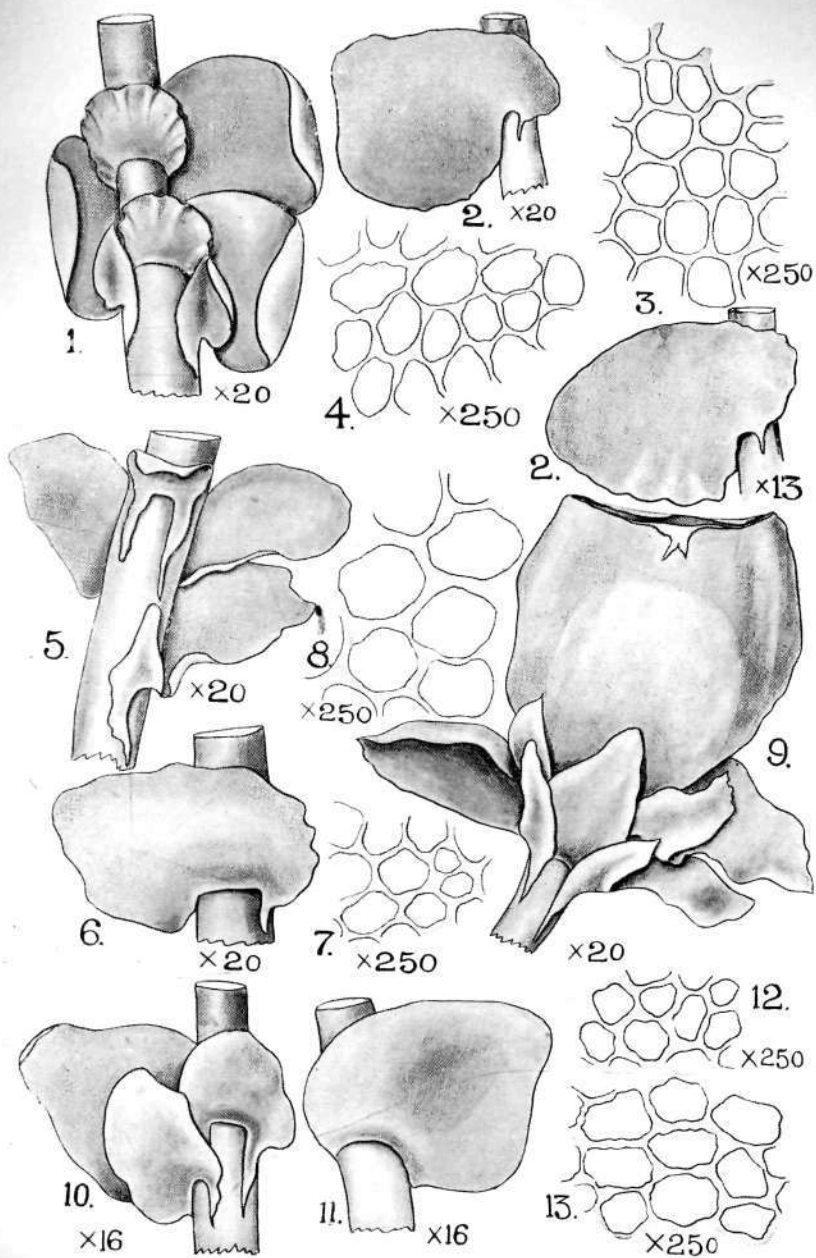


PLATE IX.

PLATE X.

MADOTHECA GRACILLIMA. 1—5.

1. Two shoots, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Median cells.
5. Basal cells.

MADOTHECA OBTUSIFOLIA. 6—10.

6. A shoot, from below.
- 6 (a). Two leaves with lobules, from below.
7. A leaf attached to the stem, from above.
8. Upper cells.
9. Median cells.
10. Basal cells.

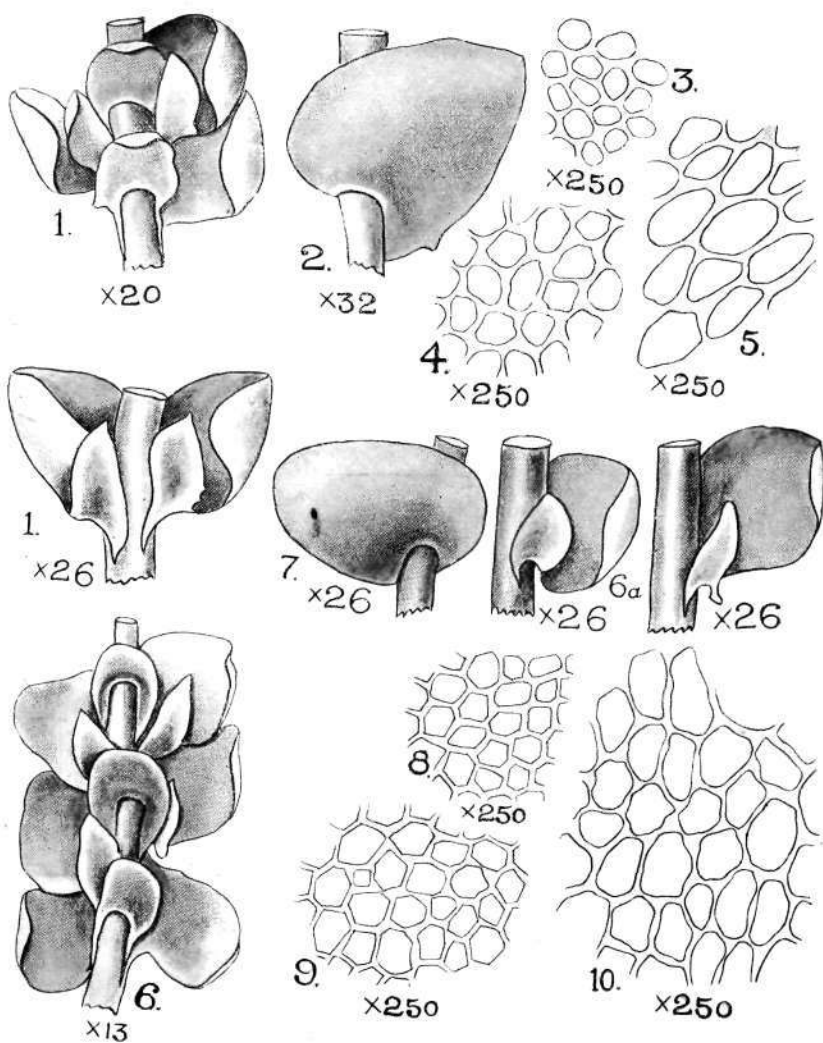


PLATE X.



PLATE XI.

*RADULA COMPLANATA*. 1—4.

1. A sterile shoot, from below.
- 1 (a). A fertile shoot, from below.
2. A leaf attached to the stem, from above.
3. Marginal gemmae.
4. Median cells.

*DIPLOPHYLLUM ORIENTALE*. 5—9.

5. A fertile shoot, from above.
6. Dorsal lobe, from above.
7. Ventral lobe, from below.
8. Upper cells with one tooth.
9. Basal cells.

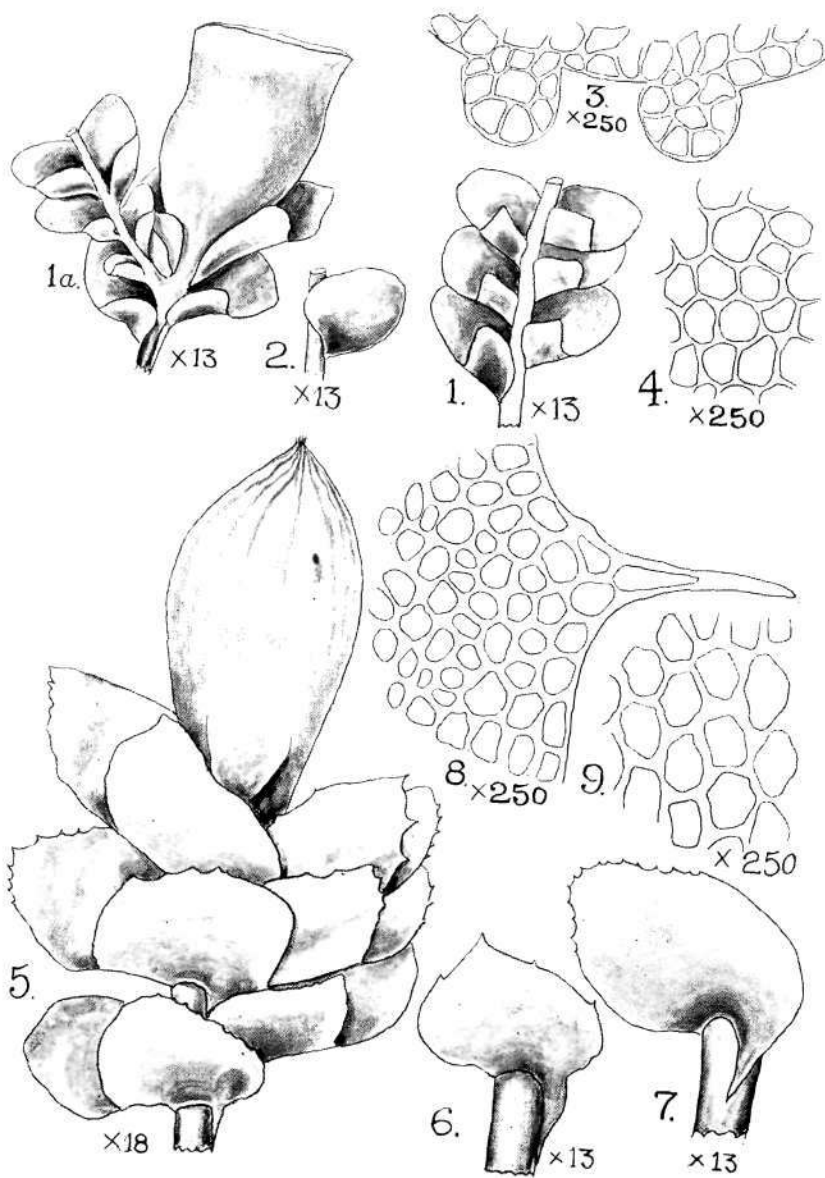


PLATE XI.

PLATE XII.

SCAPANIA VERRUCOSA. 1—7.

1. A shoot, from below.
2. A leaf attached to the stem, from above.
3. Upper cells.
4. Median cells.
5. Basal cells.
6. T.S. leaf.
7. T.S. leaf (through the keel).

SCAPANIA PURPUREA. 8—13.

8. A shoot, from below.
9. A shoot, from above.
10. A leaf, from above.
11. Upper cells.
12. Basal cells.
13. T.S. leaf.

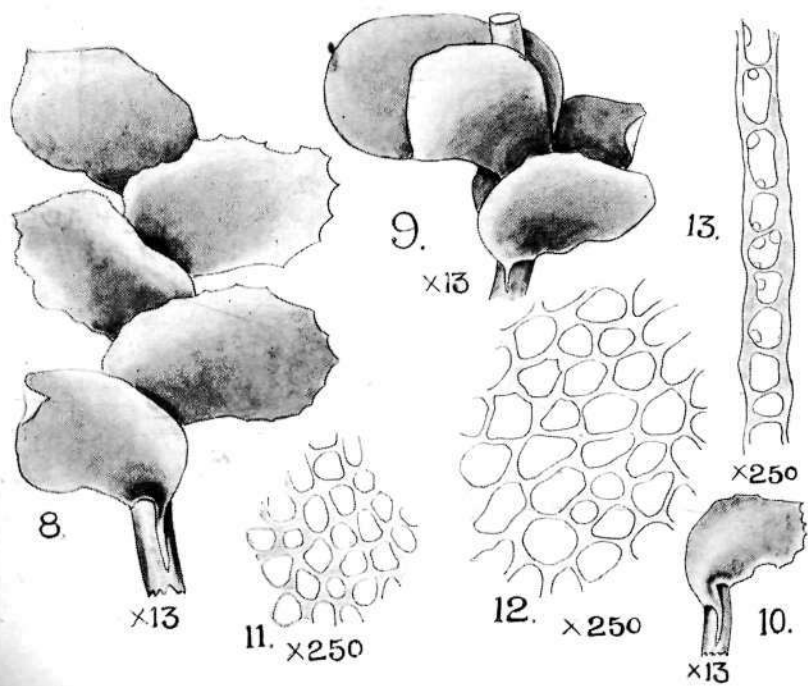
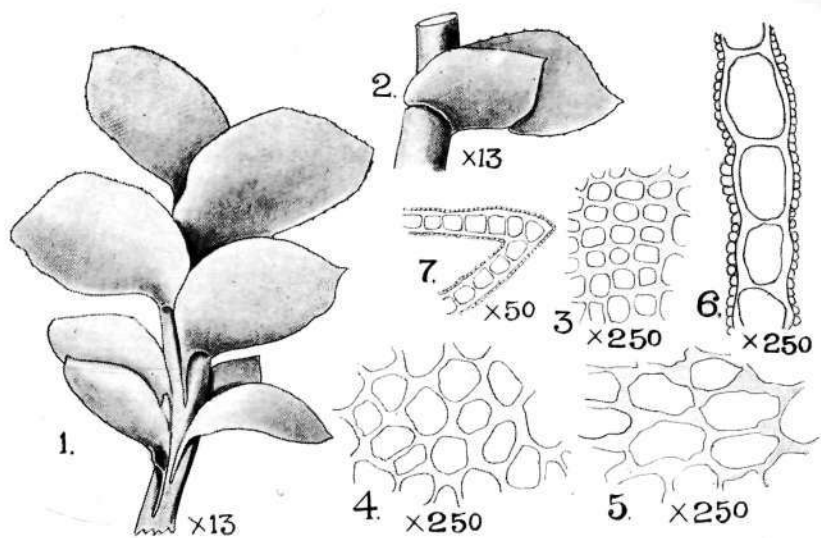


PLATE XII.

PLATE XIII.

ANTHELIA JULACEA. 1—2.

1. A sterile shoot.
- 1 (a). A perianth with involucre.
2. Leaf cells.

BLEPHAROSTOMA TRICHOPHYLLUM. 3—4.

3. A sterile shoot.
- 3 (a). A shoot with perianth.
4. Leaf cells.

MASTIGOBRYUM TRIANGULARE. 5—9.

5. A shoot, from below.
6. A leaf attached to the stem, from above.
7. Upper cells.
8. Median cells.
9. Basal cells.

CALYPOGEIA RENISTIPULA. 10—13.

10. A shoot, from below.
11. Upper cells.
12. Median cells.
13. Basal cells.

CEPHALOZIA GOLLANI. 14—18.

14. A sterile shoot, from below.
15. A female plant, side view.
16. Upper cells.
17. Basal cells.
18. Bracts and bracteole,

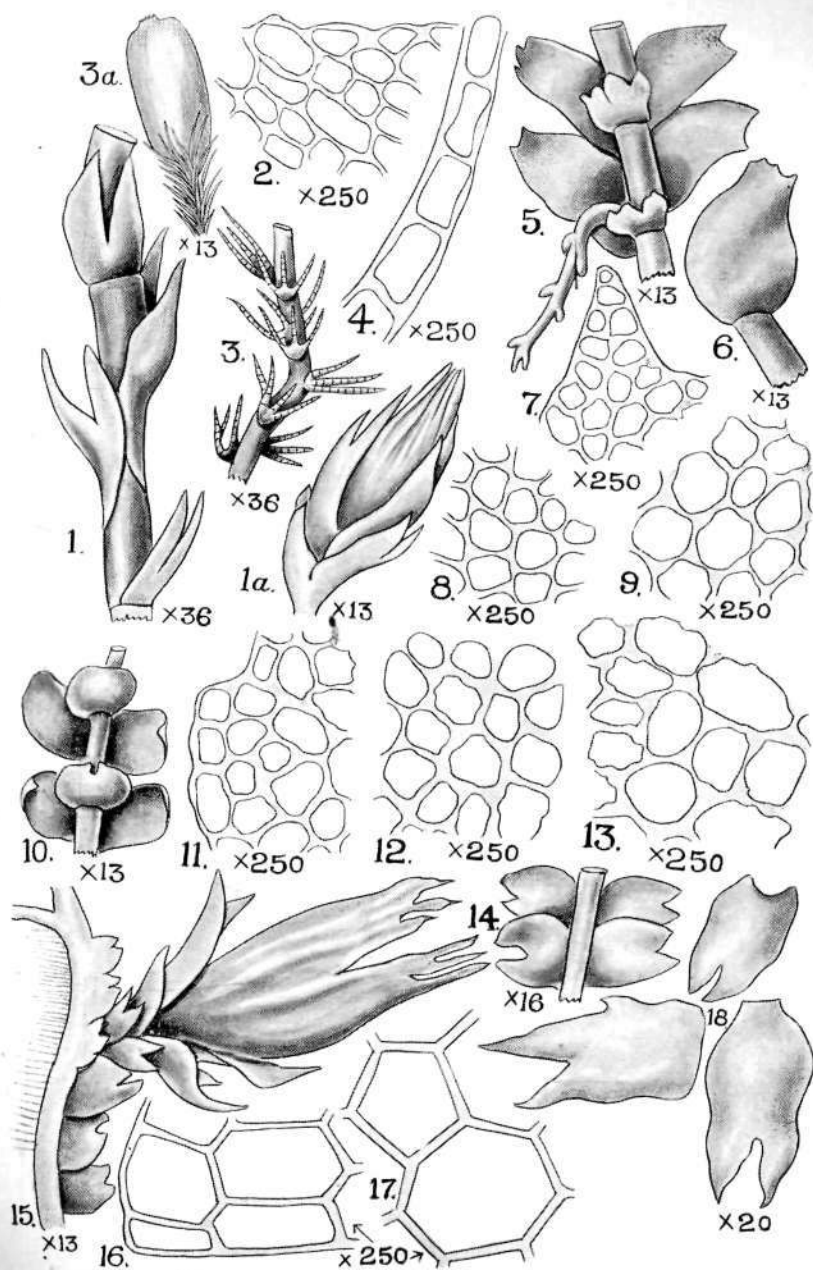


PLATE XIII.

PLATE XIV.

CHILOSCYPHUS INFLATUS. 1—4.

1. A shoot, from above.
2. A shoot, from below.
3. Upper cells.
4. Basal cells.

CHILOSCYPHUS ARGUTUS. 5—7.

5. A shoot, from below.
6. Upper cells.
7. Basal cells.

CHILOSCYPHUS HIMALAYENSIS. 8—14.

8. A male shoot.
9. A plant with antheridia and a female shoot.
10. A sterile shoot, from below.
11. 4 Amphigastria.
12. Spores and an elater.
13. Upper cells.
14. Basal cells.

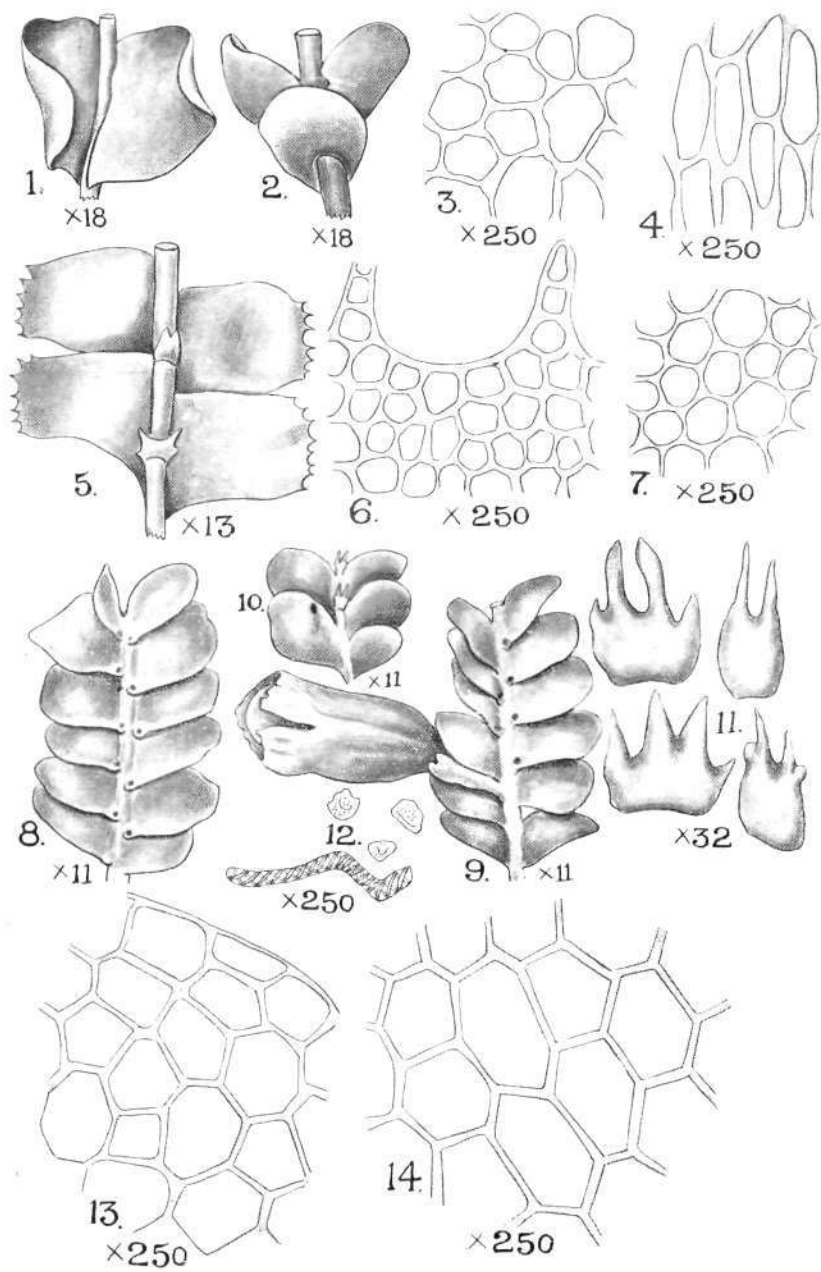


PLATE XIV.



PLATE XV.

CHILOSCYPHUS POLYANTHUS. 1—3.

1. A shoot, from above.
- 1 (a). An amphigastrium.
2. Upper cells.
3. Basal cells.

CHILOSCYPHUS CAMPANULATUS. 4—8.

4. A shoot, from below.
5. A male shoot, from above.
6. A female shoot.
7. Upper cells.
8. Basal cells.

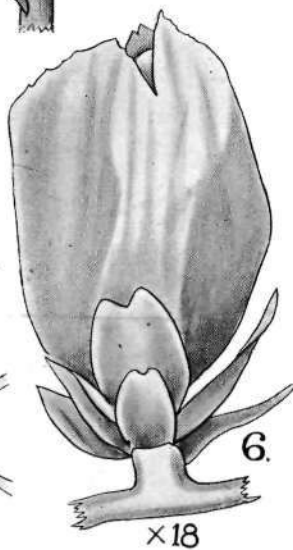
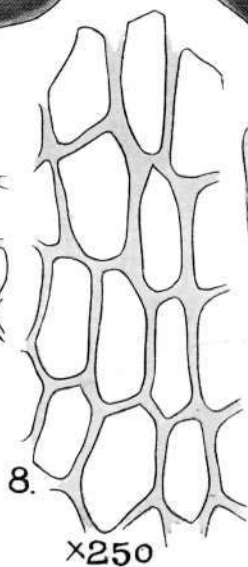
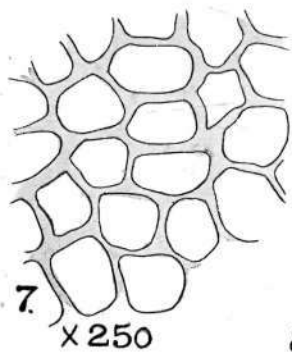
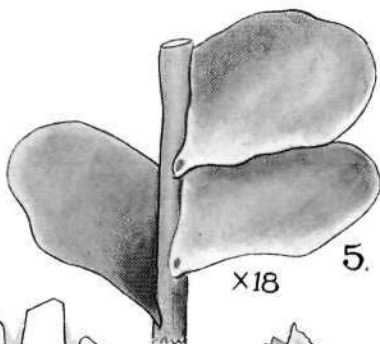
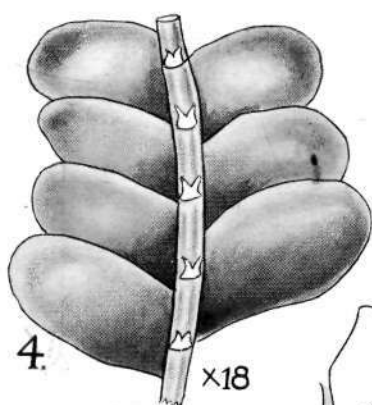
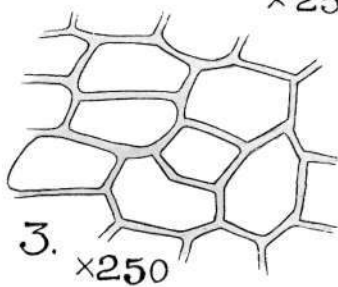
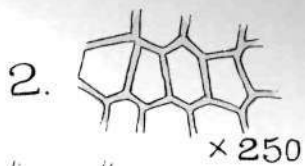
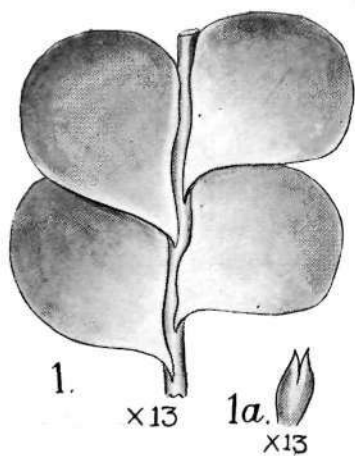


PLATE XV.

PLATE XVI.

LOPHOCOLEA BIDENTATA. 1—8.

1. Female shoot, from above.
2. Sterile shoot, from below.
3. Two male bracts.
4. Upper cells.
5. Basal cells.
6. A bract.
7. Two bracteoles.
8. The perianth flattened out.

LOPHOCOLEA HETEROPHYLLA. 9—14.

9. Two shoots.
10. An amphigastrium.
11. Two bracteoles.
12. Upper cells.
13. Median cells.
14. Basal cells.

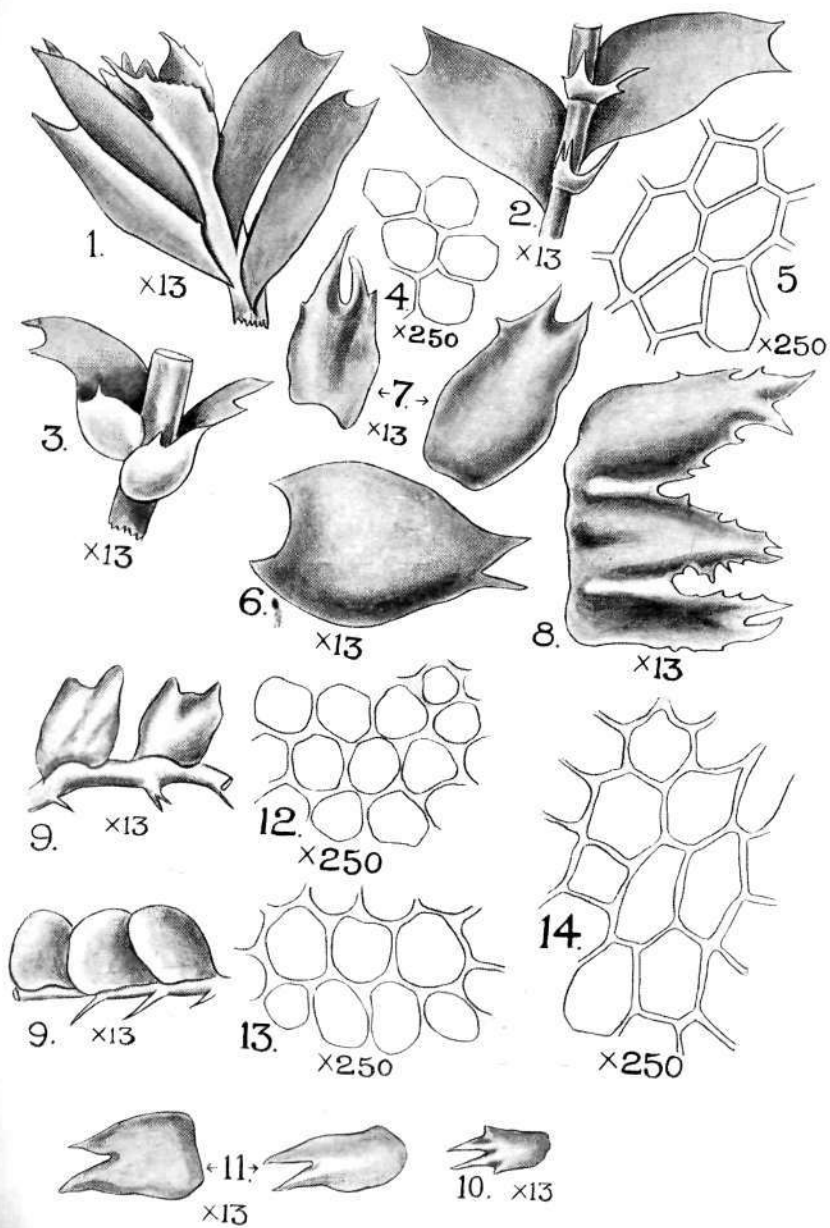


PLATE XVI.

PLATE XVII.

LOPHOCOLEA MINOR. 1—2.

1. A plant, from above.
2. Leaf cells.

LOPHOCOLEA ALATA. 3—6.

3. A plant, from above.
4. Involucre and perianth.
5. Upper cells.
6. Basal cells.

PLAGIOCHILA MUNDALIENSIS. 7—12.

7. A shoot, from above.
8. A leaf attached to the stem, from below.
9. Two leaves.
10. A tooth.
11. Upper cells.
12. Basal cells.

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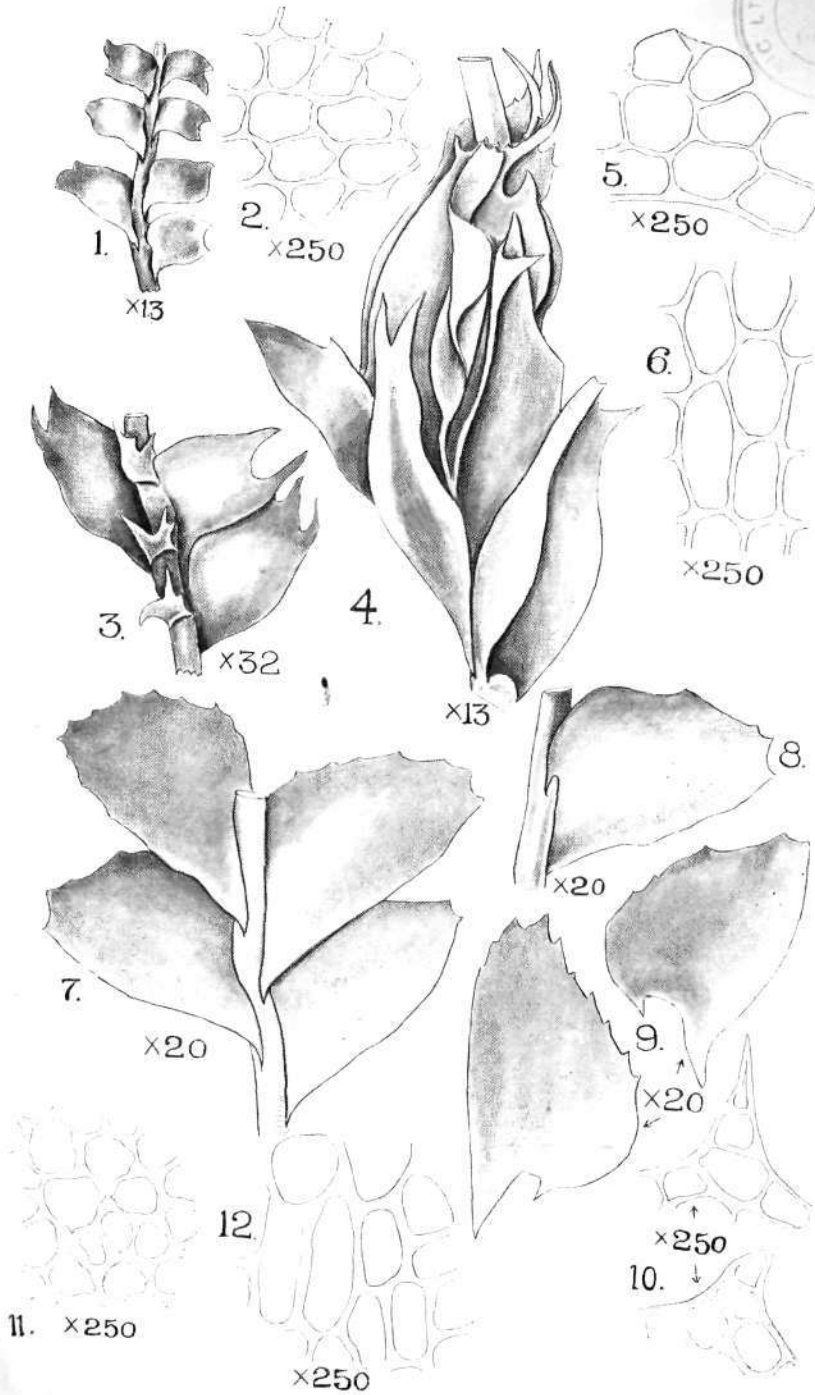


PLATE XVII.

PLATE XVIII.

PLAGIOCHILA SIMLANA. 1—6.

1. A shoot, from above.
2. A leaf attached to the stem, from below.
3. A leaf.
4. Two teeth.
5. Upper cells.
6. Basal cells.

PLAGIOCHILA MITTENII. 7—12.

7. A shoot, from above.
8. A leaf attached to the stem, from below.
9. A leaf.
10. A tooth.
11. Upper cells.
12. Basal cells.

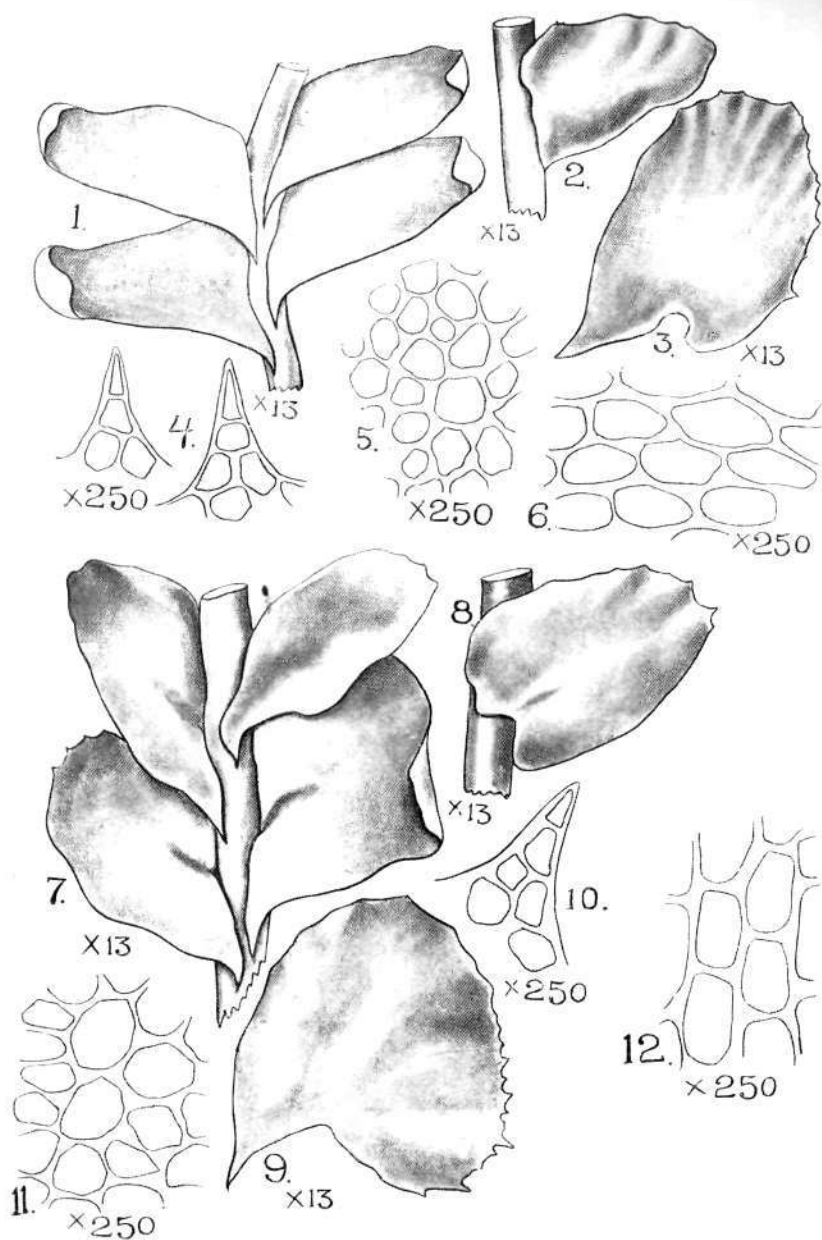


PLATE XVIII.



PLATE XIX.

PLAGIOCHILA FERRUGINEA. 1—6.

1. A shoot, from above.
2. A leaf attached to the stem, from below.
3. A leaf.
4. Three teeth.
5. Upper cells.
6. Basal cells.

PLAGIOCHILA ACCEDENS. 7—12.

7. A shoot, from above.
8. A leaf attached to the stem, from below.
9. A leaf.
10. Two teeth.
11. Upper cells.
12. Basal cells.

PLATE XX.

PLAGIOCHILA SP. A. 1—7.

1. A shoot, from above.
2. A leaf attached to the stem, from below.
3. A leaf.
4. Upper cells.
5. Median cells.
6. Basal cells.
7. An involucre bract.

PLAGIOCHILA SP. B. 8—13.

8. A plant, from above.
9. A leaf attached to the stem, from below.
10. A leaf.
11. A tooth.
12. Upper cells.
13. Basal cells.

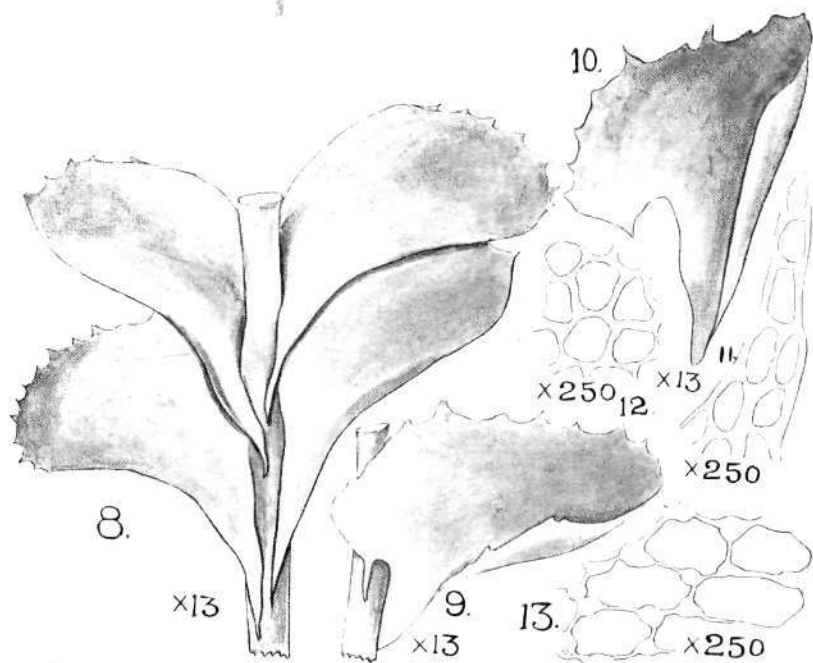
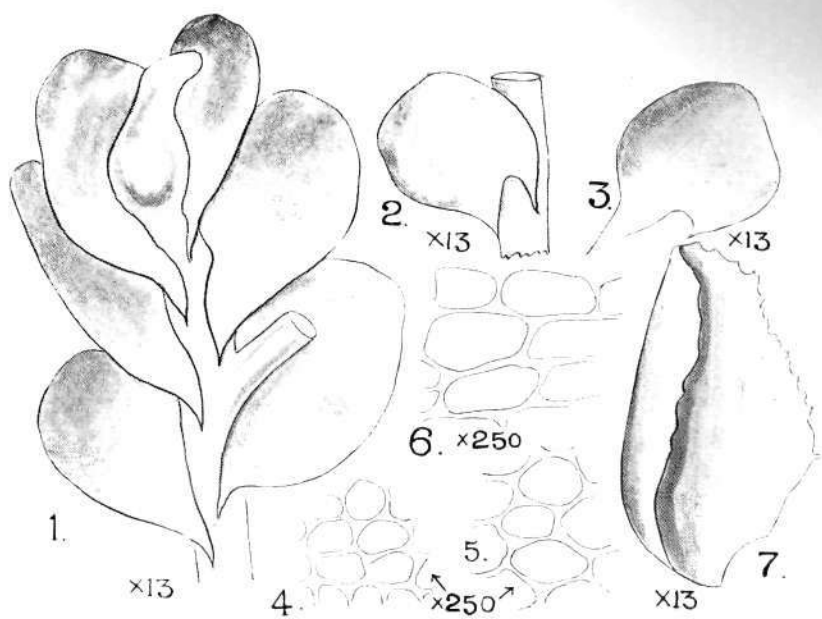


PLATE XX.

PLATE XXI.

LOPHOZIA ALPESTRIS. 1—5.

1. A shoot, from above.
2. A leaf attached to the stem.
3. Upper cells.
4. Median cells.
5. Basal cells.

LOPHOZIA INCISA. 6—9.

6. A shoot, from above.
7. Three leaves.
8. Two teeth.
9. Median cells.

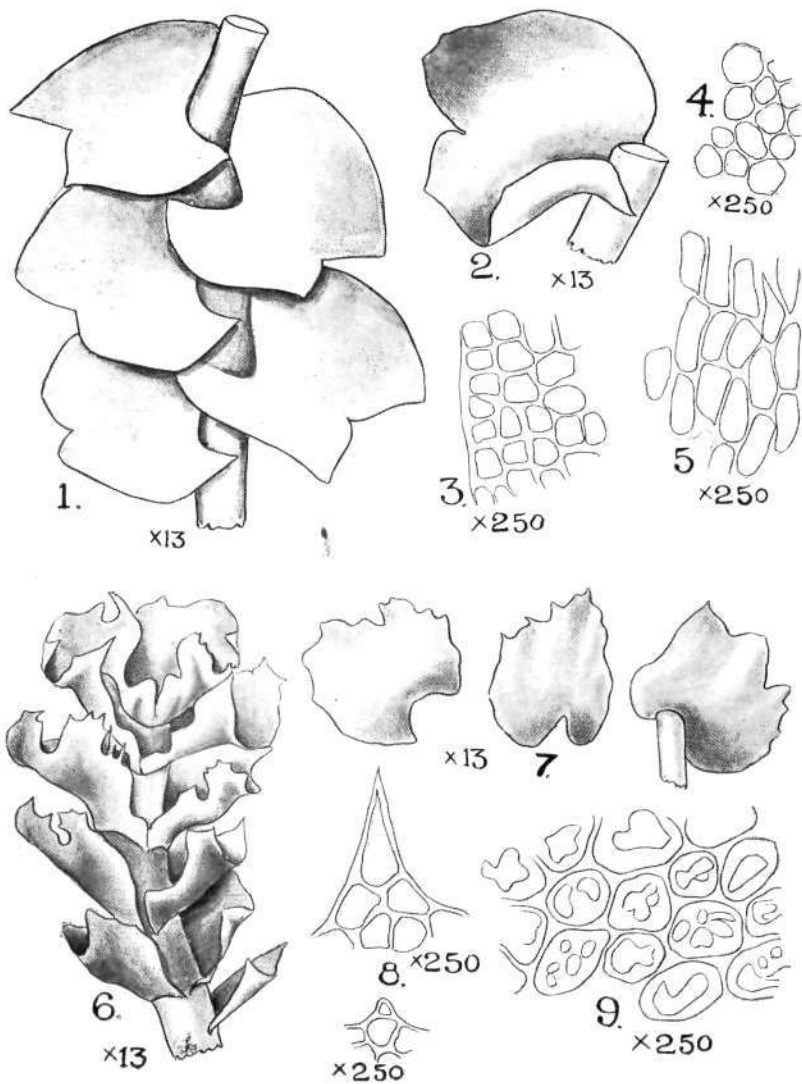


PLATE XXI.

PLATE XXII.

LOPHOZIA SP. 1—3.

1. A shoot, from above.
2. A leaf.
3. Median cells.

JAMESONIELLA ELONGELLA. 4—9.

4. A fertile shoot, from above.
5. A fertile shoot, side view.
6. Upper cells.
7. Basal cells.
8. A bract and bracteole.
9. Perianth flattened out.

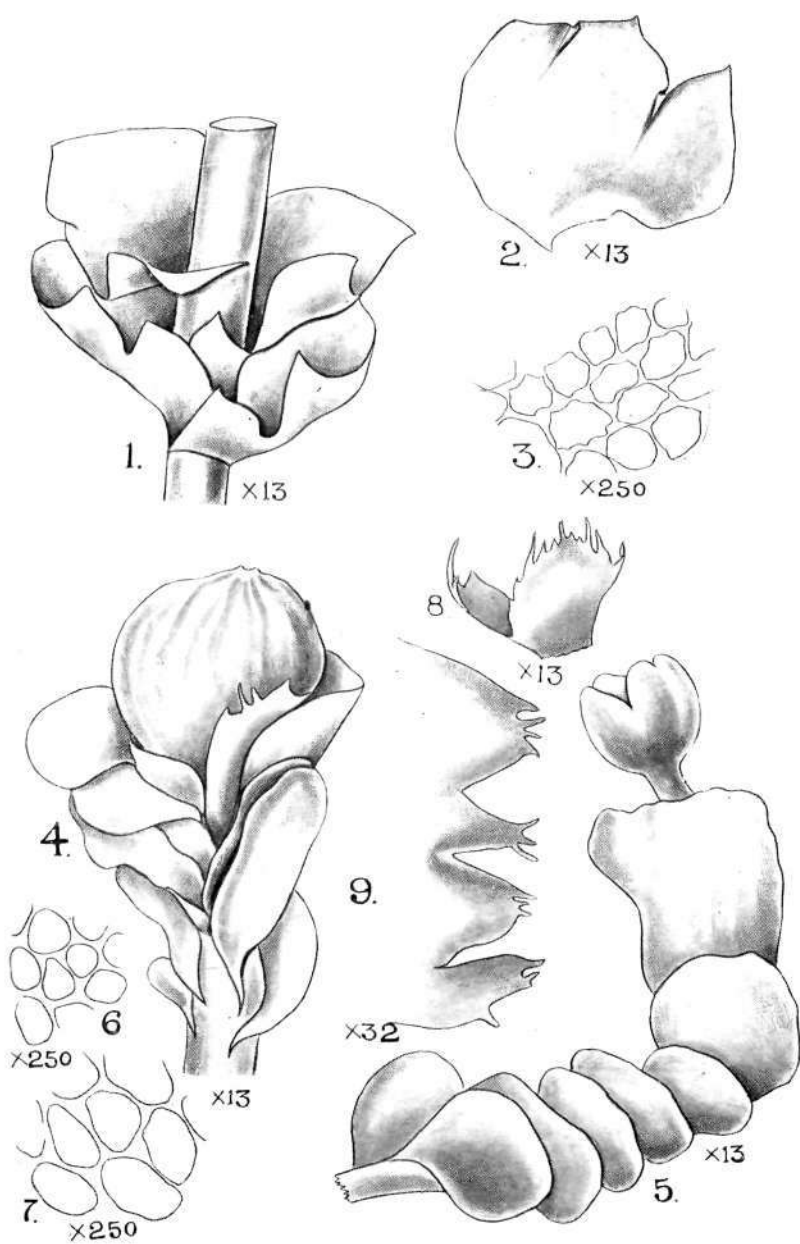


PLATE XXII.

PLATE XXIII.

SOLENOSTOMA LANCEOLATA. 1—3.

1. A fertile shoot, from above.
2. Upper cells.
3. Basal cells.

SOLENOSTOMA CRENULATA. 4—5.

4. A fertile shoot.
5. Median cells.

SOLENOSTOMA BREVIFLORA. 6—10.

6. A shoot, from above.
7. A leaf.
8. Upper cells.
9. Median cells.
10. Basal cells.



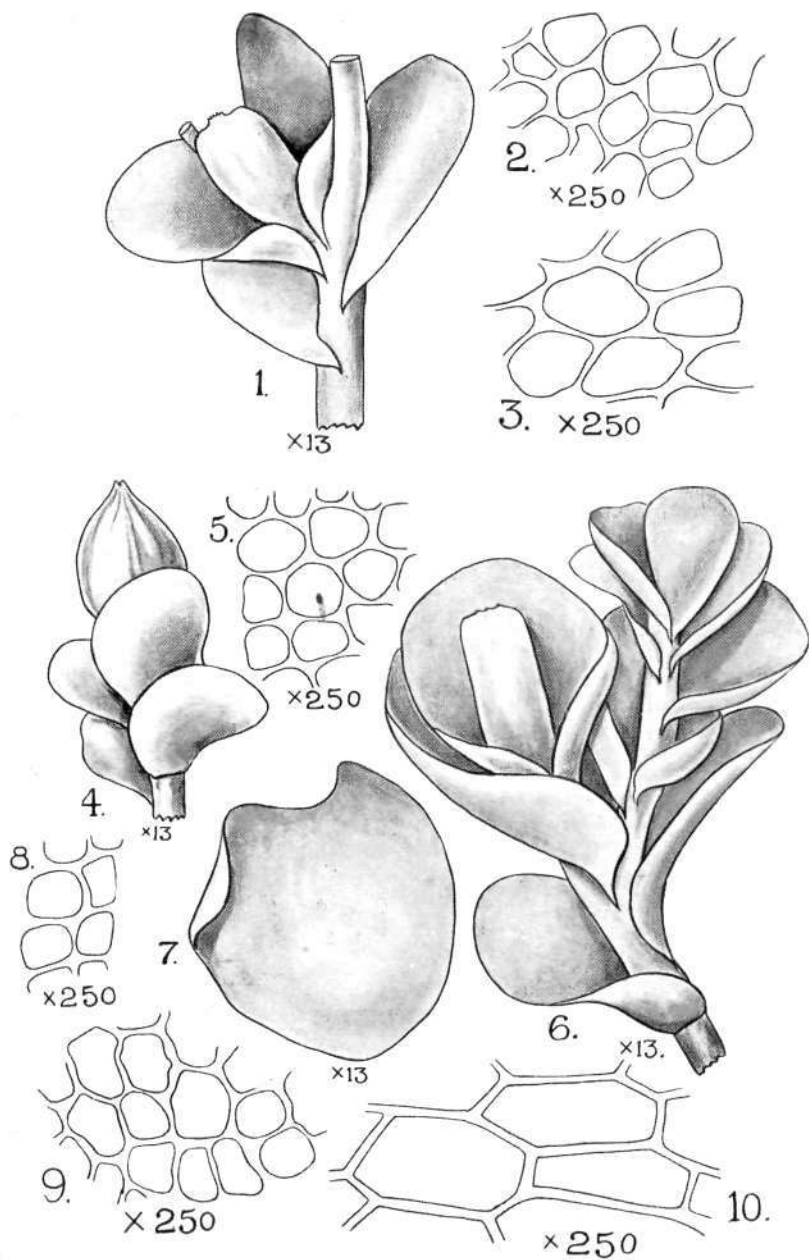


PLATE XXIII.

PLATE XXIV.

SOLENOTOMA PURPURATA. 1—4.

1. A plant.
2. Upper cells.
3. Median cells.
4. Basal cells.

JUNGERMANNIA OBLONGIFOLIA. 5—10.

5. A fertile plant.
6. A sterile shoot.
7. A leaf.
8. Upper cells.
9. Median cells.
10. Basal cells.

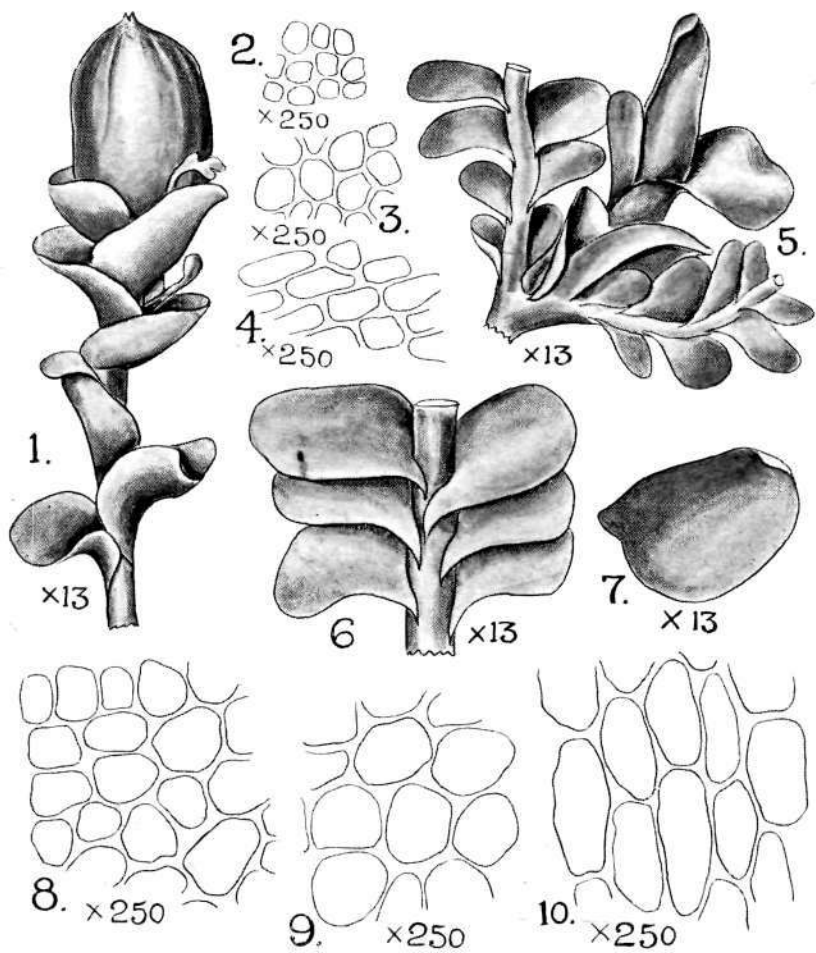


PLATE XXIV.

PLATE XXV.

*JUNGERMANNIA VIRIDIS*. 1—4.

1. A sterile shoot, from above.
2. A fertile shoot, from above.
3. Upper cells.
4. Basal cells.

*JUNGERMANNIA HUMILIS*. 5—7.

5. A sterile shoot, from above.
6. Upper cells.
7. Basal cells.

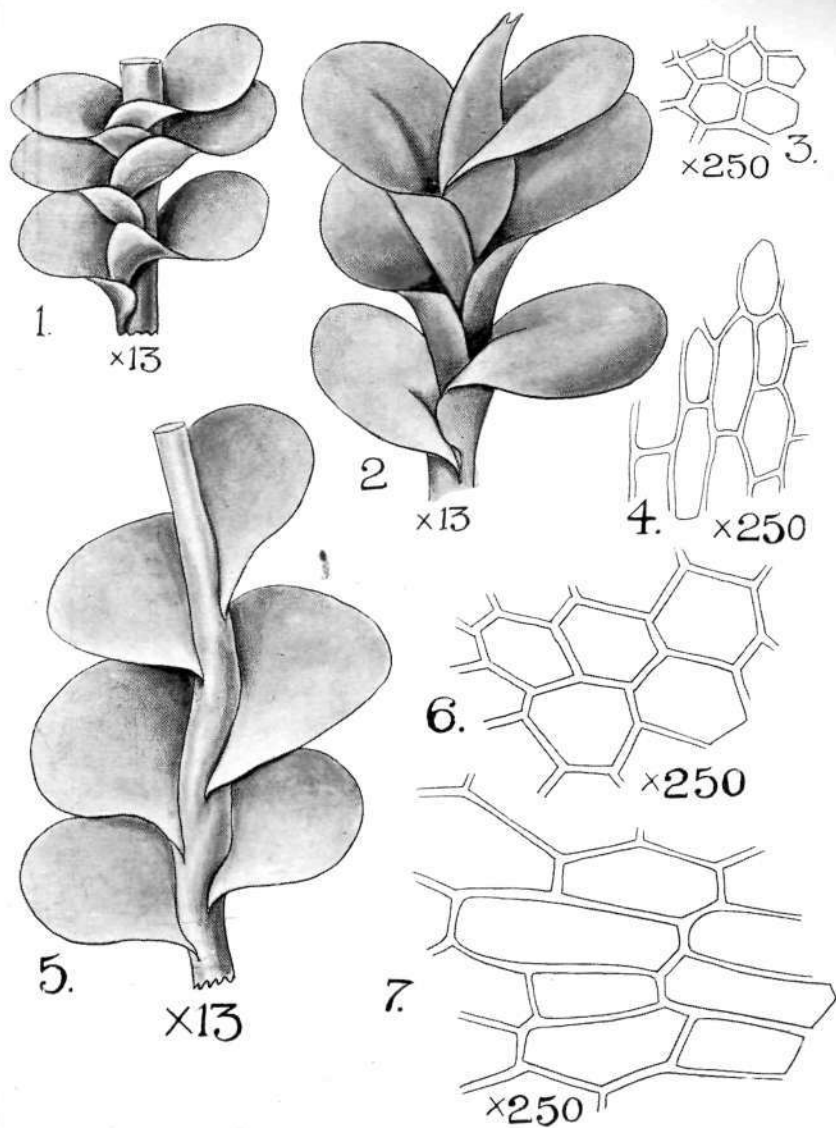


PLATE XXV.

PLATE XXVI.

PETALOPHYLLUM INDICUM. 1—5.

1. A male plant.
2. A female plant.
3. Perianth with sporogonium.
4. An elater.
5. Two spores.

SEWARDIELLA TUBERIFERA. 6—10.

6. A forked male plant, from above (left) and from below (right). Note the tubers in the latter.
7. Two female plants. In the specimens to the left the wings have been removed on one side to show the sporogonium. Note the bends in the stem indicating the growth of several years.
8. A perianth cut open.
9. A spore.
10. An elater.

FOSSOMBRONIA HIMALAYENSIS. 11—15.

11. A male plant.
12. Two female plants. In the specimen to the right note the characteristic bend in the stem and the apical tuber.
13. A spore.
14. An elater.
15. Portion of the capsule wall.

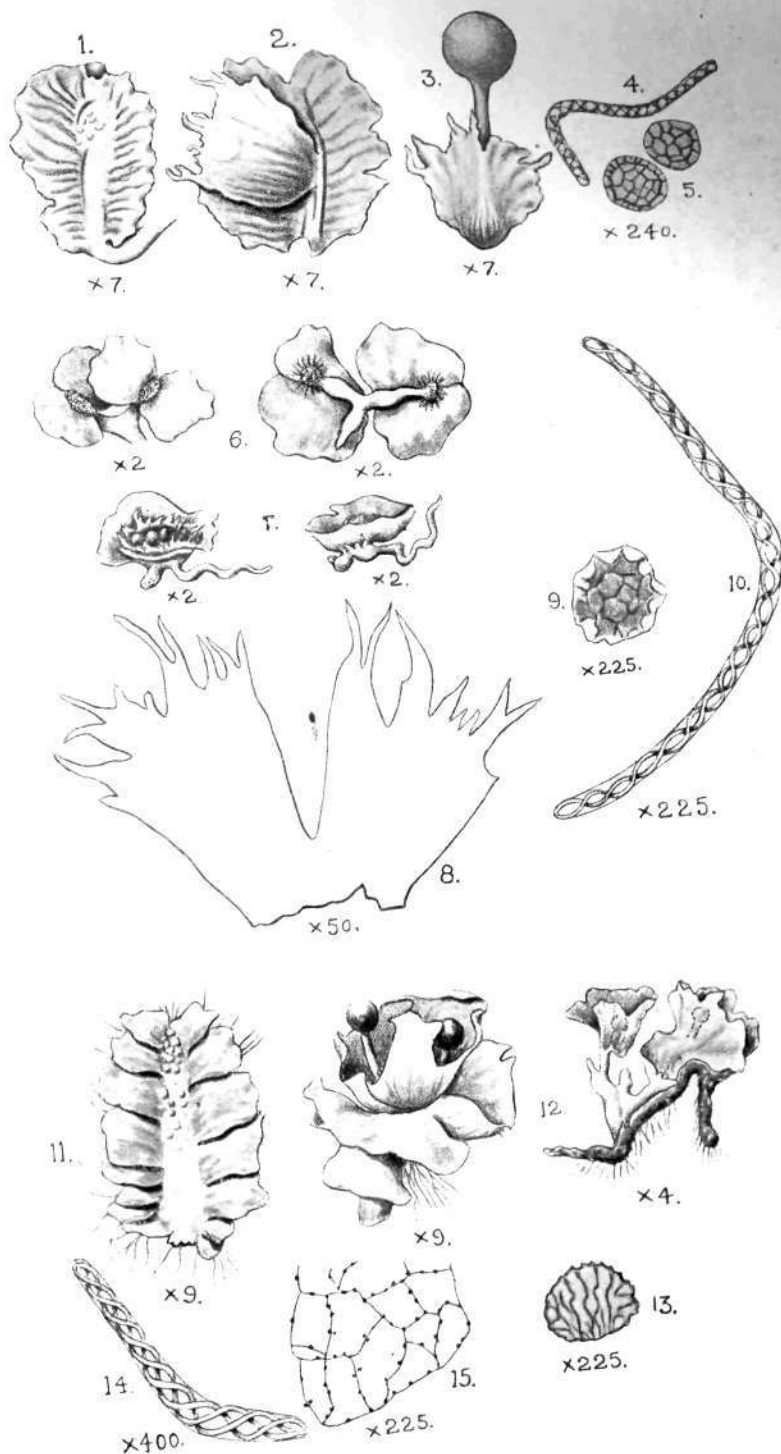


PLATE XXVI.

PLATE XXVII.

BLASIA PUSILLA. 1—4.

1. A plant with flask-shaped gemmae receptacles.
2. An amphigastrium.
3. Two stellate gemmae.
4. A gemma from the flask-like receptacle.

PELLIA CALYCINA. 5—6.

5. A fertile plant.
6. T.S. Thallus.

PELLIA EPIPHYLLA. 7—8.

7. A plant.
8. T.S. Thallus.

PELLIA NEESIANA (after Macvicar). 9—10.

9. A plant.
10. Inner wall of the capsule.



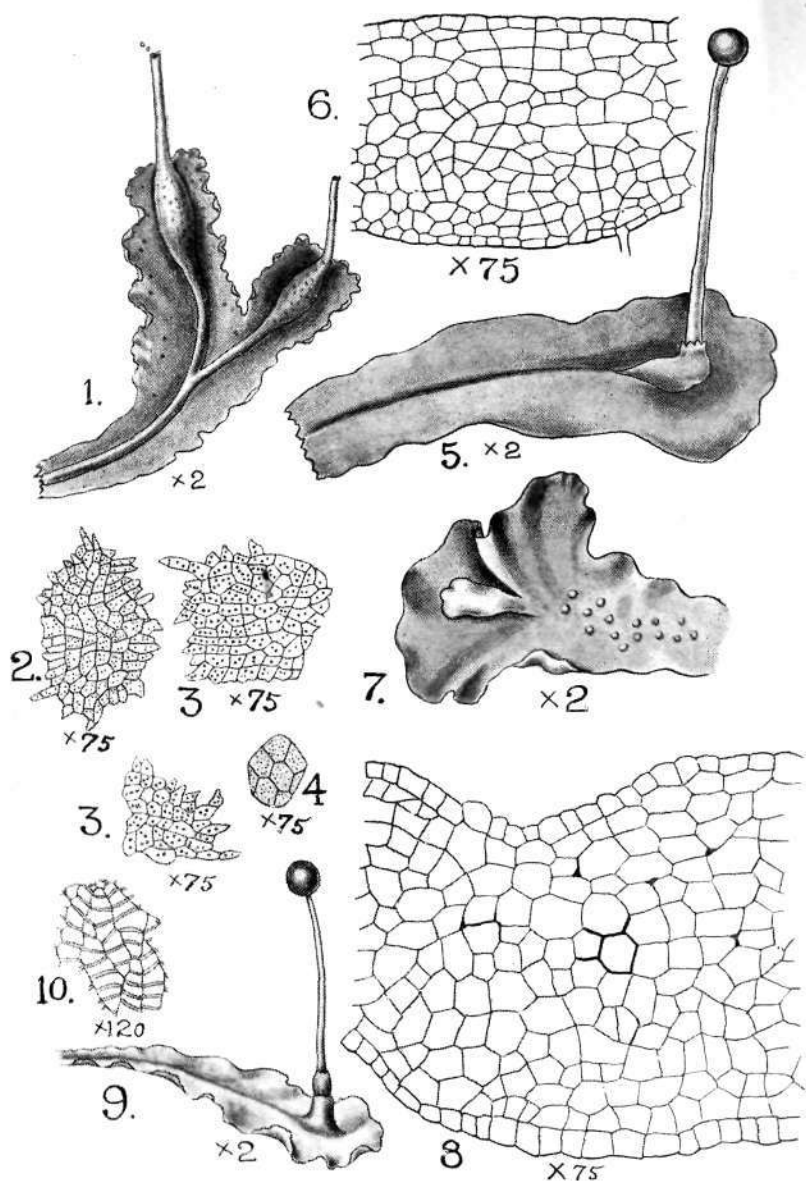


PLATE XXVII.

PLATE XXVIII.

CALYCULARIA CRISPULA. 1—6

1. A male plant.
2. A female plant.
3. Another male plant.
- 3 (a). A male bract.
4. T.S. Thallus.
5. A portion of the above more magnified.
6. Three amphigastria.

CALYCULARIA COMPACTA. 7—9.

7. A male plant.
8. } Two female plants.
9. }

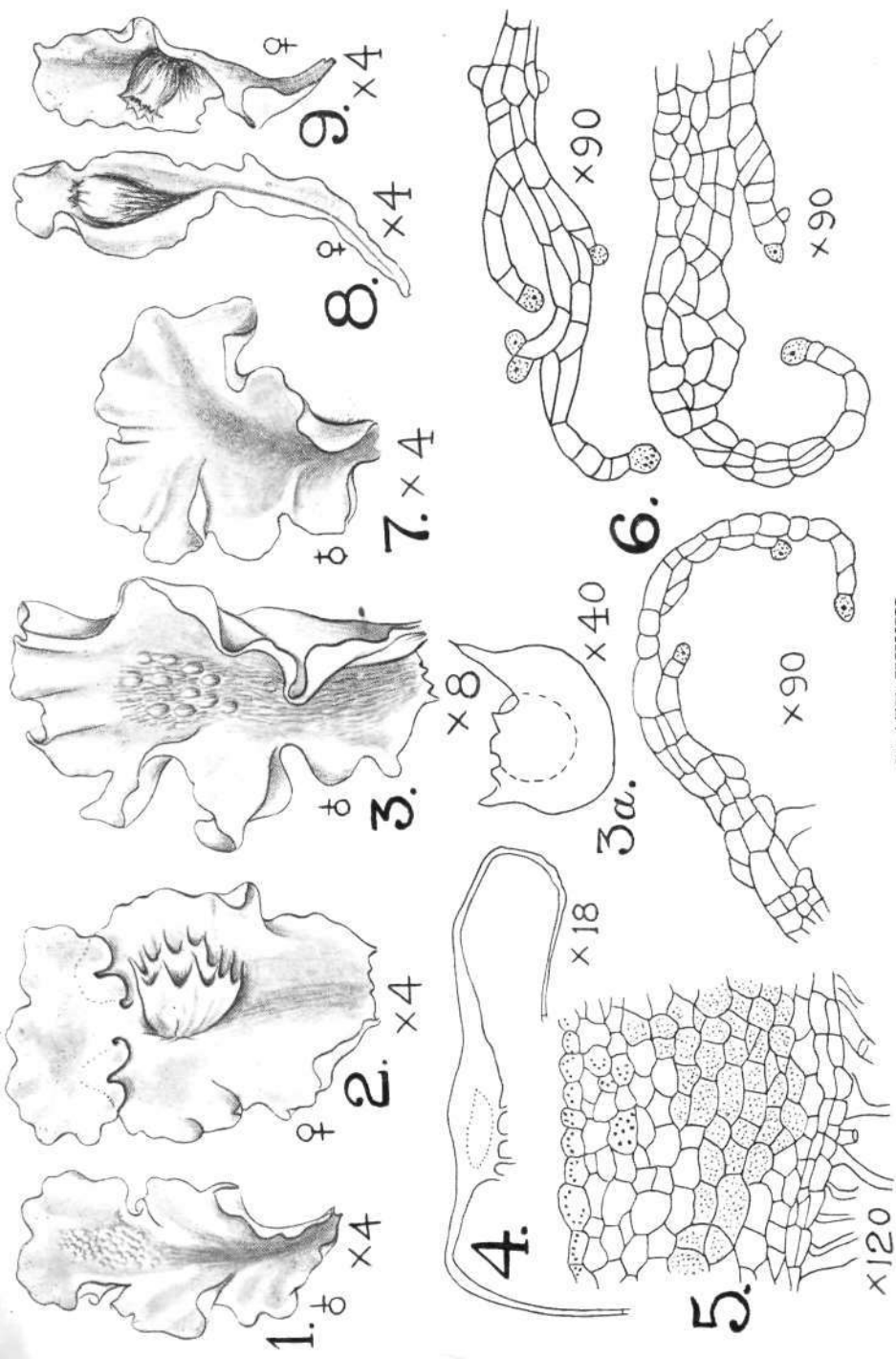


PLATE XXVIII.

PLATE XXIX.

ANEURA INDICA. 1--6.

1. A sterile plant.
2. A male plant.
3. A female plant.
4. T.S. Thallus, from *Simla specimens*.
- 4 (a). Portion of the above, more highly magnified to show epidermis.
5. T.S. Thallus, from Chamba Valley specimens.
- 5 (a). Portion of the above, more highly magnified to show epidermis.
6. T.S. Thallus, from Sialkot specimens.
- 6 (a). Portion from a similar section more highly magnified to show epidermis.

ANEURA LEVIERI. 7.

7. A plant.

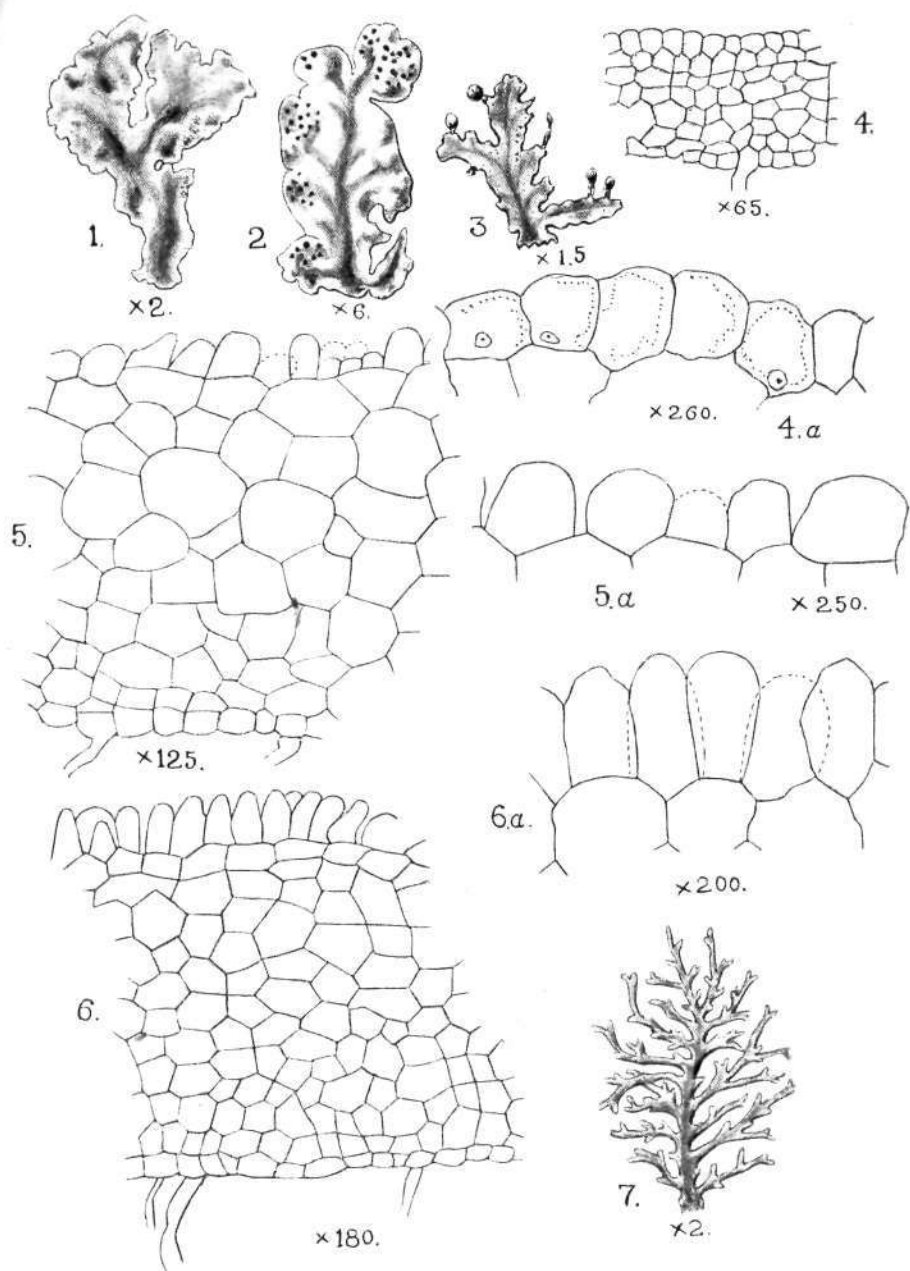


PLATE XXIX.

PLATE XXX.

METZGERIA PUBESCENS. 1—3.

1. Four plants showing habit.
2. Two T.S. Thallus.
3. Part of the wing, surface view.

METZGERIA HIMALAYENSIS. 4—6.

4. A plant.
5. T.S. Thallus.
6. Part of the wing, surface view with marginal hairs.

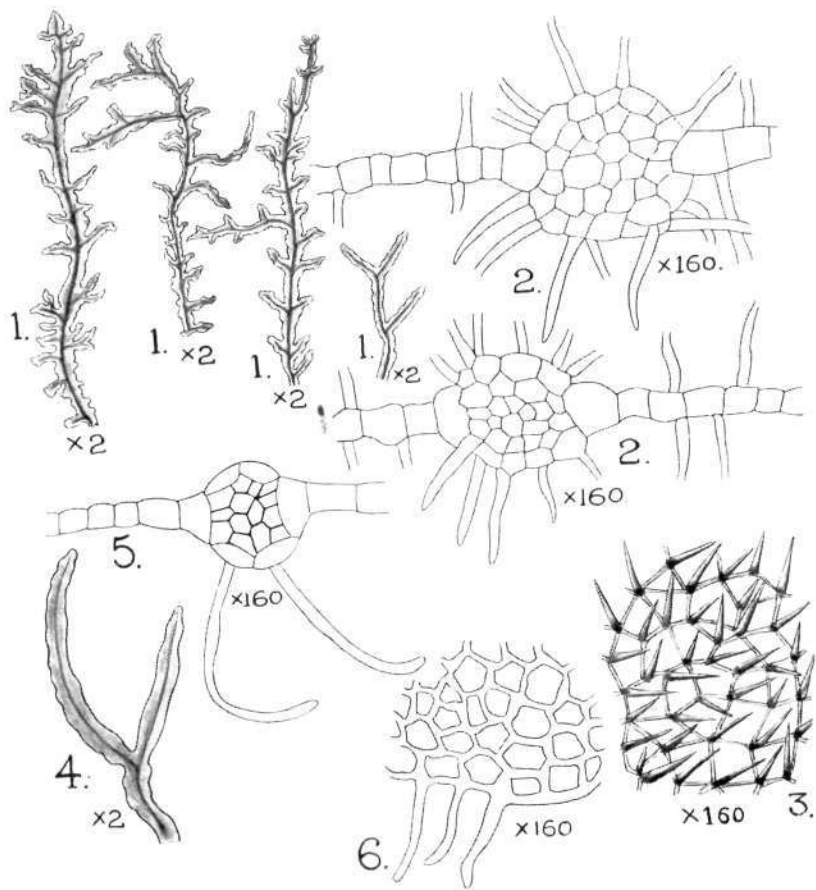


PLATE XXX.



PLATE XXXI.

RIELLA INDICA. 1.

1. Four plants showing habit.



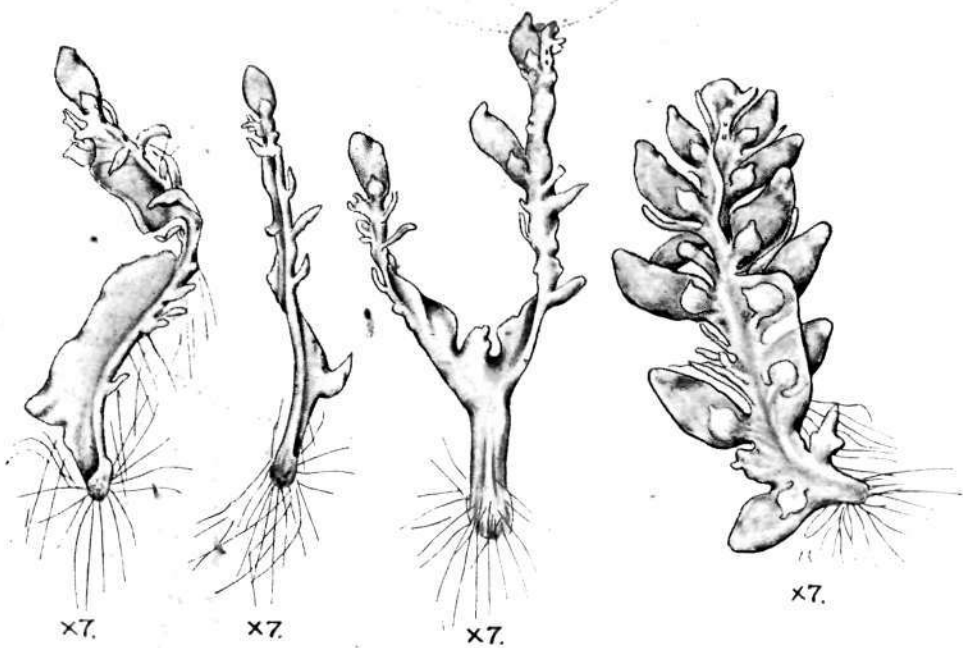


PLATE XXXI.

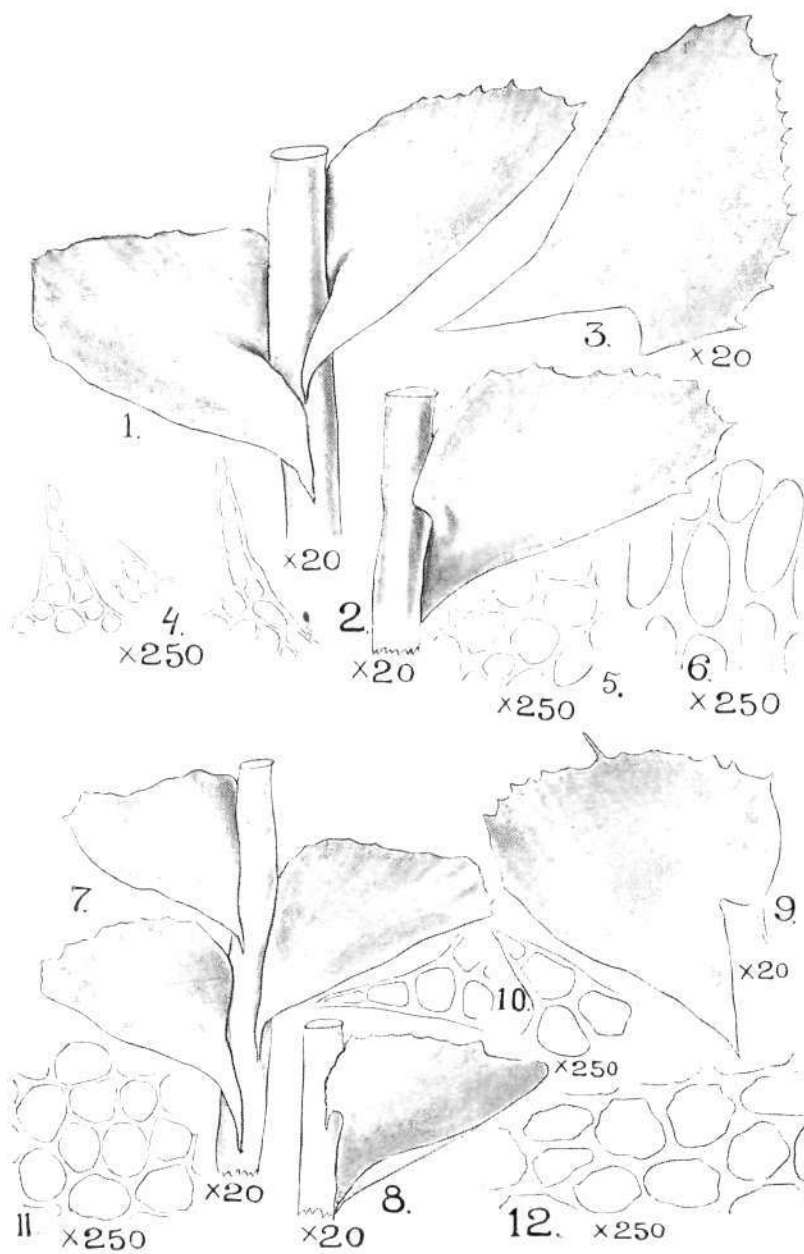


PLATE XIX.